



Chemical Methods of Weed Control

N.Z. Department of Agriculture

Bulletin No. 329



By L. J. MATTHEWS, Weeds Research Officer,

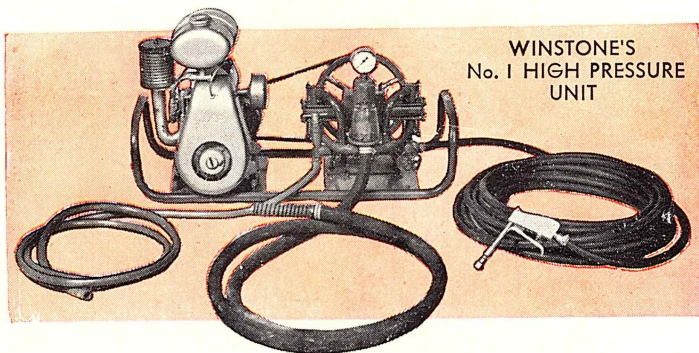
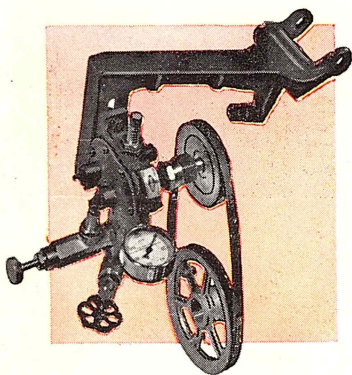
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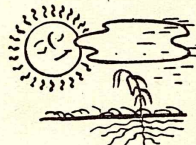


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L. J. MATTHEWS

Chemical Methods
of
Weed Control

NEW ZEALAND DEPARTMENT OF AGRICULTURE
WELLINGTON

1956

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C O P Y R I G H T P R O V I S I O N S

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Chemical Methods of Weed Control

By

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Wellington

Possibly no subject in the whole field of agricultural technology has advanced as rapidly in recent years as has chemical methods of weed control. This bulletin summarises the progress made to date in this field in New Zealand.

The bulletin is divided into four sections. The first section deals with the properties of chemicals and summarises their uses. Section 2 supplies detailed information on the control of many of New Zealand's worst weeds

and section 3 gives recommendations for the control of weeds in crops, pastures, and other specific areas. Section 1 must be consulted if knowledge is required about the properties and uses of the chemicals recommended in sections 2 and 3. Section 4 gives a brief description and the extent of the worst weed problems in New Zealand. This information is of value to overseas people who are interested in New Zealand's weed problems.

SECTION 1 — CHEMICAL WEEDKILLERS AND THEIR PROPERTIES

The chemical weedkillers dealt with may be classified broadly as hormone weedkillers, grass weedkillers, phenols, soil sterilants, crop desiccants, growth-retarding chemicals, and miscellaneous chemicals.

Hormone Weedkillers

Hormone weedkillers, more correctly called growth-regulating compounds, form an important group. Most weeds fall into the category of broad-leaved flowering plants and many are destroyed by this group of chemicals. The hormone weedkillers are non-poisonous to other than plant life, non-corrosive, and relatively easy and pleasant to use.

The wide use of these chemicals may be attributed to the fact that they are highly selective, being relatively low in toxicity to members of the grass family when applied to the foliage and with few exceptions highly toxic to other broad-leaved plants. As with other chemicals specificity of hormones is relative; at sufficiently high rates they will kill most species, including grasses. Their efficiency is probably due to their movement in the plant. When applied to the foliage most of the hormone preparations have the power of moving or translocating from the leaves into the roots, where they exert toxic effects. Unlike the older types of contact herbicides, such as sodium chlorate and arsenicals, plants

TABLE 1: HORMONE WEEDKILLERS AVAILABLE IN NEW ZEALAND

Parent Acid	Formulation	Trade Name	Acid Equivalent (in lb.)	Volatile, or of low volatility	Water or oil soluble	Effective for the control of
M.C.P.	Sodium salt	Stantox MCP 30	3.0 per gallon	L.V.	Water	Annuals, herbaceous perennials, and hormone tolerant crops
		Agroxone 3	3.0 " "	L.V.	"	
		Phoxylene	3.0 " "	L.V.	"	
		Yates Reliable MCP	3.0 " "	L.V.	"	
	Potassium salt	Tuloxone	3.0 " "	L.V.	"	
2,4-D	Sodium salt	Weedar MCP 4	*4.0 per gallon	L.V.	Water	Annuals, herbaceous perennials, and hormone tolerant crops
		Agroxone 4	*4.0 per gallon	L.V.	"	
		Stantox MCP 4	*Based on 2,4 isomer content			
		Yates Reliable MCP 4				
		Phenoxone	0.75 per lb.	L.V.	Water	
	Sodium salt	Yates Reliable Sodium Salt	0.75 " "	L.V.	Water Soluble Powder	
		Stantox 80	0.72 " "	L.V.		
		Frenokone	0.72 " "	L.V.		
		Economone	0.72 " "	L.V.		
		Weedar 77	4.8 per gallon	L.V.	Water	
	Alkanolamines unspecified	Weedar S (sequestered)	4.0 " "	L.V.	"	
		Yates Reliable Amine Salt	4.5 " "	L.V.	"	
		P.P. Amine 2,4-D	4.5 " "	L.V.	"	
		Phordene	5.0 " "	L.V.	"	
		Stantox 2,4-D	1.0 " "	L.V.	"	
		Stantox 64	4.0 " "	L.V.	"	
		Dee Cee Pee	4.5 " "	L.V.	"	
		Ataweed	1.25 " "	L.V.	"	
		Yates Reliable 2,4-D Concentrate				
		Weedone 57 Volatile	3.6 per gallon	V.	Oil	
Ethyl ester		Stantox Aero Concentrate	3.6 " "	V.	"	Annuals, semi-woody perennials, and perennials with waxy or thickened leaves
		Stantox P 44	7.0 " "	V.	"	
		Ethone	4.0 " "	V.	"	
		Relionus, 2,4-D Concentrate	3.6 " "	V.	"	
		D. 40	3.6 " "	V.	"	
		Winstones 2,4-D	4.0 " "	V.	"	
			4.0 " "	V.	"	

TABLE 1: HORMONE WEEDKILLERS AVAILABLE IN NEW ZEALAND (continued)

Parent Acid	Formulation	Trade Name	Acid Equivalent (in lb.)	Volatile, or of low volatility	Water or oil soluble	Effective for the control of
2,4-D	Butoxy ethanol ester	Weedone 57 N.V. Weedone LV-4 N.V. "Aeroconcentrate 115" N.V.	3.6 per gallon 4.0 " " 7.2 " "	L.V. L.V. L.V.	Oil " "	Annuals, semi-woody perennials, and
	Butyl ester	Phordester	3.0 per gallon	V.	Oil	perennials with waxy or thickened leaves
	Polyethylene glycol ester	Weedone "PEG" Yates Reliable PEG Stantox Dock Killer	4.0 per gallon 4.0 " " 4.0 " "	L.V. L.V. L.V.	Water " "	perennials with waxy or thickened leaves
	2 ethyl butanol ester	Stantox P 44 N.V.	4.0 per gallon	L.V.	Oil	Suitable for specified weeds only
2,4-D } 2,4,5-T }	Butoxy ethanol esters	Weedone Brushkiller "32" Weedone Standard N.V.	1.6 per gal. 2,4-D 0.8 " " 2,4,5-T 0.6 " " 2,4-D 0.3 " " 2,4,5-T	L.V. L.V.	Oil "	Brush or scrub plants, e.g.: Gorse and blackberry, and for killing clovers in playing greens
	Ethyl ester Butyl ester	Stantox T 45	2.0 " " 2,4-D 2.0 " " 2,4,5-T	V.	Oil	Oil
2,4,5-T	Butyl ester	Butoxone Relionus 2,4,5-T concentrate Summit 2,4,5-T Yates Reliable 2,4,5-T Weedone Special V. Stantox T 45 S Phortox Winstones 2,4,5-T	3.6 per gallon 3.6 " " 3.6 " " 3.6 " " 3.6 " " 3.0 " " 3.6 " "	V. V. V. V. V. V. V.	Oil " " " " " "	Oil
		Weedone Special N.V. Weedone LV-4 (T) N.V.	3.6 per gallon 4.0 " "	L.V. L.V.	Oil "	Oil
		Yates Reliable N.V. 2,4,5-T Stantox T 45 S.N.V.	3.6 per gallon 3.6 per gallon	L.V. L.V.	Oil Oil	Oil
	Butoxy ethanol ester					
	Monobutyl glycol ether ester					
	2 ethyl butanol ester					

sprayed with hormone preparations may take several weeks or several months to die.

Classification of Hormone Weedkillers

Table 1 classifies the various proprietary lines of hormone weedkillers available in New Zealand, with their uses.

Parent acids: All proprietary lines of hormone weedkillers available in New Zealand are derived from the parent acids M.C.P. (2 methyl, 4 chlorophenoxyacetic acid), 2,4-D (2,4-dichlorophenoxyacetic acid), and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). Other parent acids such as 4-C (4-chlorophenoxyacetic acid), 3,4-D (3,4-dichlorophenoxyacetic acid), and M.C.P.B. (2 methyl, 4 chloro-phenoxybutyric acid), are still largely experimental and up to date no proprietary material is available. Closely related parent acids, viz., 2,4-DP (2,4-dichloropropionic acid) and 2,4,5-TP (2,4,5-trichlorophenoxypropionic acid), are available in the United States, but these materials are still in the experimental stage in New Zealand.

M.C.P. acid: Recently, suitable analytical methods have been determined to isolate the chemicals that were contained in M.C.P. preparations. It is now known that formulations of M.C.P. did contain not only M.C.P. but other impurities that decreased the herbicidal selectivity of M.C.P., such as for clovers. New proprietary lines are now available in New Zealand that contain relatively pure M.C.P. These preparations are marked with an asterisk in Table 1. Trials employing these preparations based on relatively pure M.C.P. have given much better results than the other preparations that contain impurities.

Comparison of M.C.P. and 2,4-D and 2,4,5-T

Now that relatively pure proprietary lines of M.C.P. are available in New Zealand, M.C.P. preparations should be used more widely than in the past. M.C.P. in many cases has proved more toxic to plants than 2,4-D. At the same time M.C.P. is considerably more selective on wheat, barley, oats, maize, potatoes, and linseed. It is also more selective on mature clovers than 2,4-D,

particularly for red clovers. At very low rates of application M.C.P. water-soluble preparations may be used for weed control in peas. M.C.P. oil-soluble preparations have proved as toxic, or more so, than similar preparations of 2,4-D on some woody species such as (1) Spanish heath (*Erica lusitanica*), (2) barberry (*Berberis vulgaris*). In comparison with 2,4,5-T both M.C.P. and 2,4-D appear to move more freely than 2,4,5-T in the plants that they affect. As contact chemicals for the destruction of annuals both 2,4-D and 2,4,5-T are more toxic than M.C.P.

Mixtures of 2,4-D and 2,4,5-T

Table 1 shows the preparations of mixed 2,4-D and 2,4,5-T acids available in New Zealand. Most weeds in New Zealand react specifically to either 2,4-D or 2,4,5-T, for example, both gorse and blackberry are little affected by 2,4-D, but are quite susceptible to 2,4,5-T preparations. The inclusion of 2,4-D in 2,4,5-T preparations for the control of either of these weeds is not warranted. Similarly, most weeds controlled by 2,4-D do not react favourably to 2,4,5-T, for example, ragwort or Californian thistle. A further disadvantage of such preparations for pasture weed spraying is the fact that 2,4,5-T is extremely toxic to clovers. A few weeds, however, such as broom, lupin, and goat's rue are susceptible to 2,4-D in the younger stages of growth, but react more favourably to 2,4,5-T when mature and semi-woody or woody. For mixed growth stages of these weeds a combination of 2,4-D and 2,4,5-T, preferably in the proportion of 2:1, is quite valuable. On playing greens where the elimination of clovers and flatweeds is desired a combination of 2,4-D and 2,4,5-T in the proportion of 1:4 has given good results.

4-C

Preparations of this acid, 4-C, are not commercially available, but results of trials on the control of fern and other weeds have been sufficiently promising to include this material. At rates up to 8lb. acid equivalent per acre it has proved of no value for the control of gorse, blackberry, and sweet brier.

Salts, Amines, and Esters

From each of the parent acids M.C.P., 2,4-D, and 2,4,5-T, salts, amines, and esters can be formulated. This forms the basis of classification for hormone weedkillers. Table 1 shows there are 5 proprietary lines of the sodium salt of 2,4-D available in New Zealand. For users of hormone weedkillers it is much simpler to remember that the sodium salt of 2,4-D controls annual buttercups and to refer to a table such as Table 1 for the proprietary lines of material available rather than remember all the proprietary lines. If this method is adopted, users of hormone weedkillers can then take advantage of the differences in prices for the various proprietary lines available.

Salts and Amines of M.C.P.

Table 1 shows there are proprietary lines of the sodium and potassium salt of M.C.P. available. Those preparations containing the sodium salt of M.C.P. are not based only on pure M.C.P., hence the acid equivalent stated as 3.0lb. per gallon has to be reduced considerably. In contrast, those preparations listed as the potassium salt of M.C.P. are based on relatively pure M.C.P., and the acid equivalent of 4.0lb. per gallon is based only on M.C.P. and not on other impurities as in the case of the sodium salt preparations.

The potassium salt of M.C.P. is more soluble than the sodium salt. In England amine salts of M.C.P. are commercially available.

Sodium Salts and Amines of 2,4-D

Sodium salt preparations are only 4 per cent. soluble, hence are always sold as a powder, but for ease of mixing with water a 3 per cent. solution should be employed, that is 3lb. of sodium salt to 10 gallons of water. The sodium salt of 2,4-D is often employed in proprietary mixes of fertilisers such as hormonised superphosphate.

The amine salts of 2,4-D are highly soluble in water and those preparations that do not contain a sequestering agent are affected by excessively hard water.

Comparison of Salts and Amines of M.C.P. and 2,4-D

Under most New Zealand conditions no differences have been noted in toxicity between the salts and amines of M.C.P. and between the salts and amines of 2,4-D. On the whole the salts and amines of M.C.P. penetrate the leaves of the plants more quickly than the sodium salt of 2,4-D and to a less extent the amines of 2,4-D. The sodium salt of 2,4-D tends to dry out into a crystalline deposit and the salts of M.C.P. into a non-crystalline film. If rain follows within a few hours after the application of the salts and amines of M.C.P. and 2,4-D, then the toxicity of 2,4-D salts and amines is reduced more than the corresponding preparations of M.C.P. If dry weather prevails for 3 or 4 days, then there is little or no difference in the reaction of susceptible plants to M.C.P. and 2,4-D when the salts and amines of these preparations are compared.

Esters of M.C.P., 2,4-D, and 2,4,5-T

There are three distinct types of esters—the volatile esters (such as the butyl ester), the low volatile esters (such as the butoxy ethanol ester), and a low volatile water-soluble ester (the polyethylene glycol ester). Esters of 2,4,5-T are less volatile than the corresponding esters of 2,4-D. The volatile and low volatile esters, with the exception of the polyethylene glycol ester, are oil soluble. Most esters are insoluble in water and require to be dissolved in a solvent and then an emulsifying agent added so that the formulation can be sprayed with water. For aerial spraying or basal spraying of tree stumps a solution of ester in oil is often employed. Volatile esters under hot, still, humid conditions may pass off toxic fumes that have the property of damaging susceptible plants such as tomatoes. Low volatile esters are sufficiently near non-volatile to be employed in enclosed spaces or near susceptible plants, provided spray drift does not occur. If spray drift occurs, then more damage is likely to occur through the use of low volatile materials, as spray droplets of low volatile materials tend to adhere together longer than volatile

particles; hence low volatile particles result in more damage if they drift.

Comparison of Salts, Amines, and Esters

Salts and amines are always water soluble; esters with the exception of the polyethylene glycol ester are oil soluble. The toxicity of water-soluble preparations is reduced if heavy rain falls directly after their application. Oil-soluble preparations are not affected to the same extent and are much safer to use under adverse weather conditions. Salts and amines are always of low volatility; esters are either of high volatility or of low volatility. Salts and amines penetrate the outer surfaces of plants less readily than the esters, but tend to move more freely in the plant. Salts and amines are hence less effective on plants such as periwinkle (*Vinca major*), where the outer leaf surface is thickened. On succulent, deep-rooted perennials such as Californian thistle (*Cirsium arvense*) salts and amines of M.C.P. and 2,4-D have usually given better control than the corresponding esters. In this case the salts and amines gain entry into the plants readily and move into the roots more freely than the esters. On the whole, salts and amines are more effective than esters (particularly the volatile esters) on succulent deep-rooted plants, provided the plants are growing vigorously at the time of application; growth conditions before the application are usually more important than those after the application. If the plants are not growing vigorously or are in the late seed-head stage of growth, then esters usually give the better results. Salts and amines are of little value for semi-woody and woody perennials. Esters secure the best control of this type of vegetation.

Acid Equivalents

Table 1 states the amount of acid equivalent in a gallon of weedkiller or pound of dust. The acid equivalent is the amount of actual parent material or the active principle of the preparation. In the case of the amine salts of 2,4-D the acid equivalent ranges from 1.25lb. per gallon to 4.8lb. per gallon. All recommendations will be given in

terms of pounds of acid equivalent per acre. The user, to measure out the recommended acid equivalent, must divide the acid equivalent per gallon into 8 to obtain the amount of acid equivalent per pint of material. In the case of a preparation containing 4.0lb. acid equivalent per gallon each quart of material contains 1.0lb. acid equivalent.

All proprietary lines should state the formulation and the acid equivalent on the label, for example, butyl ester of 2,4,5-T, 3.6lb. acid equivalent per gallon. Users should purchase only those proprietary lines of weedkillers so labelled.

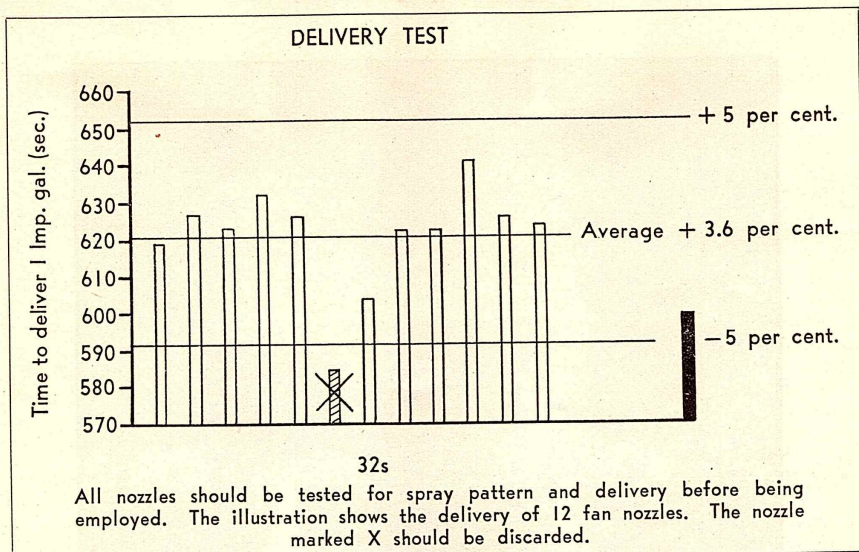
Factors Affecting Efficiency of Hormones

Correct Materials

The most important factor in the use of hormone weedkillers is the employment of correct formulation. Users should adhere strictly to the recommendations given, for example, gorse is effectively controlled by esters of 2,4,5-T. Poor results would be obtained if salts and amines of M.C.P. or 2,4-D were employed.

Stage of Growth

Annuals and perennials that arise from seedlings are most easily killed as seedlings. Resistance increases with maturity. Perennials that arise from suckers or root regrowths must have reached the stage of maximum leaf development before they are treated. The stage of maximum leaf development is noted by flower stalk initiation, for example, Californian thistle grows into a rosette stage and once the maximum rosette stage is reached a flower stalk is produced. The optimum results are obtained in the case of plants susceptible to water-soluble preparations if the application is made during the period of flower stalk initiation up until early flowering stage. In the late flowering stage and early seed-head stage esters usually secure better results. In the case of other types of woody perennials, such as blackberry, flower bud formation is an indication that the plant has reached maximum leaf development. If blackberries are sprayed in spring, canes and leaves are quickly killed



off, but far more regrowths occur than if the spraying had been delayed until flowers were present. Perennials that arise from suckers are usually laterally rooted and require more than one application for control.

Complete Foliage Cover

Liquid spray distribution over most types of plants is important, for example, complete foliage cover is essential in the use of 2,4,5-T on woody species such as gorse, and the coverage of basal leaves of perennials such as docks and ragwort is necessary to secure good results. In most cases little difference has been detected when fine or large droplet sizes have been employed. Droplets that fall near the central midrib of leaves are possibly moved more quickly than droplets falling elsewhere. Usually the best results are obtained by atomising the spray as much as possible consistent with prevailing conditions. Smaller spray particles usually penetrate into the interior foliage better than larger spray particles. As the dilution factor is not important, users should always employ sufficient water to secure good foliage cover. Excessive run-off should be avoided.

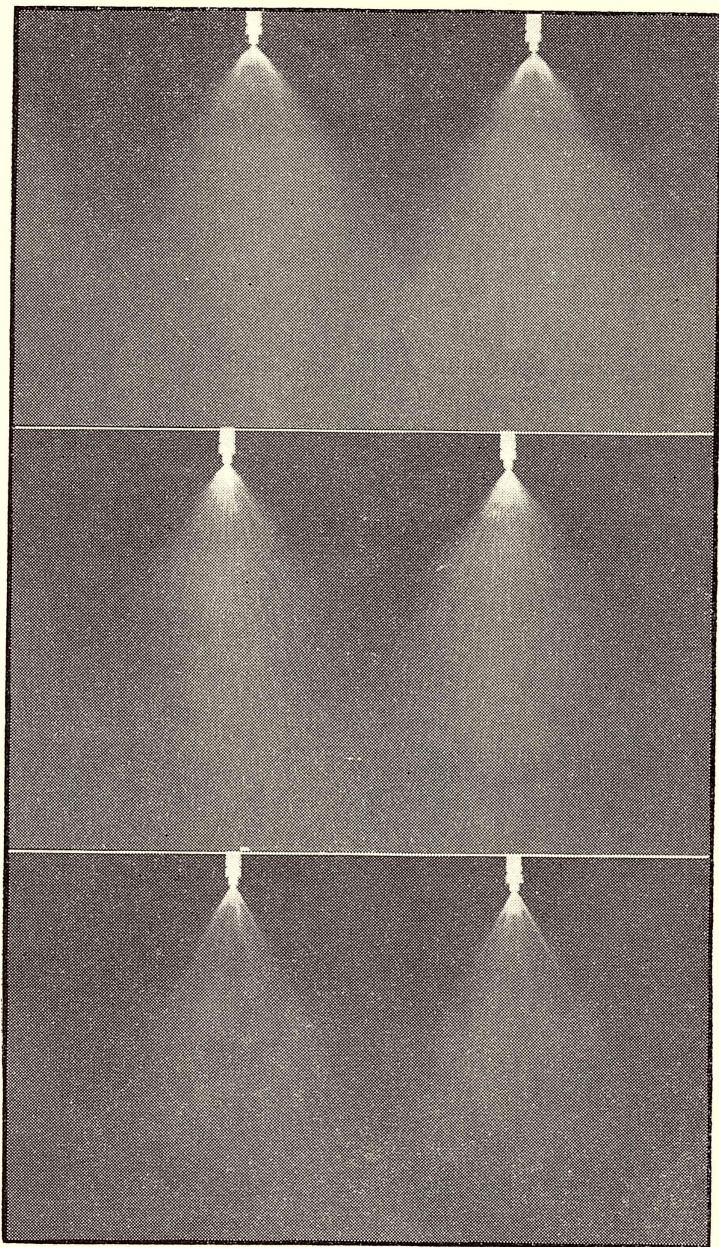
Dilution rates depend on the type of equipment, nozzle sizes, and pressures employed. Users of weedkillers should employ the amount of acid equivalent

recommended per acre in sufficient water to give a thorough coverage, but avoid excessive run-off. Only where spot treatment is practised should users employ a fixed solution such as a 5 per cent. solution.

Rates of Application

Rates of application given are arbitrary and are less important in most cases than factors such as correct material, stage of growth of plants, etc. Most plants are killed at rates of 0.5lb. to 2.0lb. acid equivalent per acre under suitable conditions. If plants do not show reaction to rates of up to 2.0lb. acid equivalent per acre, then they can be regarded as being resistant to that type of preparation. In the case of perennials that arise from root regrowths optimum results are secured if a minimum lethal dose is applied per acre. An overdose, particularly of a volatile ester, usually results in a quick foliage kill to ground level with little penetration into the roots.

Rates of application are affected by growing conditions previous to the application. Plants are most susceptible when growing vigorously under good fertility conditions. Under adverse growing conditions or low fertility conditions a higher rate of acid equivalent is required, for example, regrowth gorse up to 3ft., if sprayed



The interaction angle of spray delivery. Upper—Two hollow cone nozzles. Middle—Two solid cone nozzles. Lower—Two fan nozzles. The nozzles are set at a height of 28in. and 14in. spacings.

in the summer and early autumn months, requires up to 2lb. to 3lb. acid equivalent per acre for control; in winter control has been obtained only with rates up to 8lb. to 12lb. acid equivalent per acre.

Precautions in Use of Hormones

Care in Mixing Oil-soluble Preparations

The oil-soluble esters of 2,4-D and 2,4,5-T should form emulsion when mixed with water. Some preparations require to be "pre-mixed," that is an equal amount of ester and water should be mixed together and agitated. The required amount of water is then added. Other preparations contain "pour-in" emulsions, that is, the preparation is added to the required amount of water and agitated. It is advisable to treat all preparations as pre-mix emulsions. If small particles are discernible in the mix, then a full emulsion has not been obtained. If this occurs, the preparation should be treated as a pre-mix emulsion.

Emulsions should not be left standing without agitation. Not all preparations have their density adjusted to 1 (the density of water) and tend to settle to the bottom of the spraying tank if left unagitated.

Danger of Hormone Sprays to other Plants

Damage to neighbouring susceptible plants may be caused by spray drift or volatile fumes. Volatile preparations should not be employed in enclosed spaces or adjacent to susceptible plants of value. Spray drift can be minimised by using a large volume of water, coarse nozzles, and low pressures. Atomisation or fogging of the particles should be avoided. The application should preferably be made early in the morning or late evening when the wind is negligible and the air currents are downwards.

Seed should not be stored near volatile preparations, as the germination of some seed is markedly reduced when stored under such conditions.

Cleaning of Sprayers

If oil-soluble preparations have been used in sprayers that contain leather or rubber washers, the washers have

to be replaced before the sprayers can safely be employed for spraying highly sensitive plants such as tomatoes. The metal parts of the sprayers should be washed thoroughly and preferably soaked in ammoniated water for 24 hours. Water-soluble preparations are easier to remove from sprayers than oil-soluble preparations and it is sufficient to wash the sprayer thoroughly after soaking it in ammoniated water. An alternative method is to wash in acetone, followed by soaking in activated charcoal and water, and then washing in clean water.

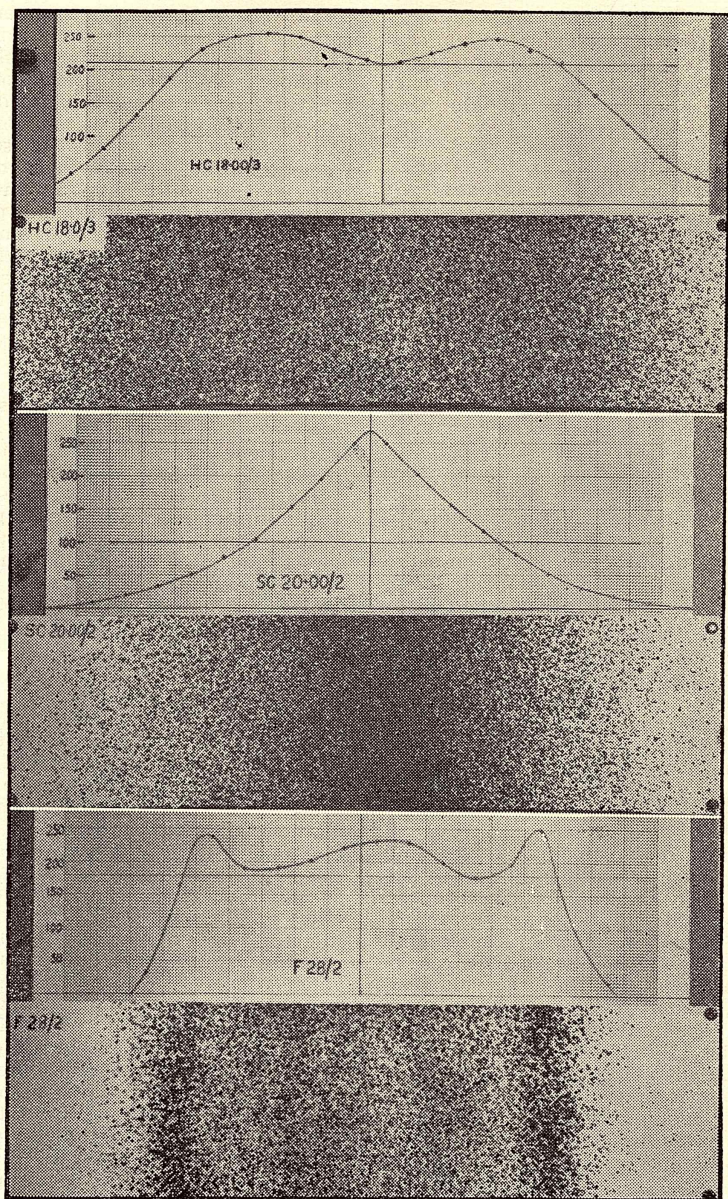
Spraying of Poisonous Plants

Some poisonous plants, such as hemlock (*Conium maculatum*), are killed by hormone sprays. Stock are attracted to susceptible sprayed plants, but the action of the hormone on the plant does not alter the poisonous properties of the plant. Non-ruminants such as horses and pigs can be poisoned by eating sprayed hemlock plants. As a control measure stock should be kept away from sprayed poisonous plants for 3 to 4 days.

Methods of Application

The most common method of applying hormone weedkillers is to the foliage of plants. This method of application is termed post-emergence application. For this type of application hormone preparations, with few exceptions, are applied in water. Applied in this way hormone weedkillers based on M.C.P., 2,4-D, and 2,4,5-T have little effect on grasses once the grasses have tillered. Browntop (*Agrostis tenuis*) possibly is the most easily damaged when young. A variant of the above method is the basal application method. Here esters of 2,4-D and 2,4,5-T as solutions or emulsions in aromatic oils are applied to the bases of trees such as willows and poplars. This type of application is best made just before the onset of spring growth. Usually an area of twice the diameter of the tree from ground level upwards is treated.

For selective weed control in crops hormone weedkillers may also be applied to the ground either before the crop is sown (pre-planting method) or after the crop is sown and before emergence of the crops. This method



Distribution graphs (top half of each illustration) and spray patterns (bottom half) of three types of spray nozzles. Upper—Hollow cone nozzle. These nozzles as single units have given the most even spray pattern. Middle—Solid cone nozzle. This type of nozzle is characterised by a high central delivery. Lower—Fan type nozzle. This nozzle is characterised by a high central and lateral delivery.

of application is called pre-emergence application. When applied to the soil hormone weedkillers control the germinating seeds of small-seeded grasses and broad-leaved plants. Germinating seeds of large-seeded weeds and crops as well as regrowth plants usually survive treatments of hormone weedkillers applied to the soil. Hormone weedkillers, when applied to the soil, depend on moisture for activation. The soil should preferably be moist at the time of application and rain should fall directly after the application. The materials are probably less effective on soils high in colloidal content than on lighter soils where leaching takes place more readily.

Preparations of 2,4-D are the least toxic materials and last about 20 to 30 days in the soil; M.C.P. preparations are intermediate in toxicity and last about 20 to 40 days, and 2,4,5-T preparations are the most toxic and remain in the soil up to 5 to 6 weeks. Esters of the above preparations are more selective than the salts and amines and in most cases the volatile esters do not persist as long as the low volatile esters. The actual period the hormones remain toxic in the soil depends on many factors such as soil type, rainfall, soil temperature, etc. The materials are decomposed by bacteria, which tend to build up in the soil. If a repeat dressing is made immediately following the loss of toxicity of the initial application, the materials are quickly broken down so

that there is no residual build-up of hormone material in the soil.

The use of the pre-planting method has not gained favour in New Zealand largely because other types of chemicals have become available, and secondly, the seed-bed has to be disturbed when the seed or crop is planted. This usually allows a fresh strike of weed seeds. In the pre-emergence method the seed-bed is not disturbed and this usually allows better weed control. Crops most suitable for pre-emergence weed control are the large-seeded crops such as maize, potatoes, and most plants with corms or bulbs, and also newly planted asparagus.

The advantages of pre-emergence weed control are that many weeds which show resistance to post-emergence applications such as willow weed, etc., are readily killed, and provided the ground is not disturbed after application, the area remains free of susceptible weeds for a considerable period.

The normal rates of application are 2lb. to 4lb. acid equivalent per acre and the best time of application is immediately after the crop is sown. Weed seeds are most susceptible when germinating and up until the radicle (embryo root) is an inch long. Those weed seeds that germinate near the surface of the ground, such as willow weed, cornbind, shepherd's purse, fat-hen, etc., are more readily controlled than weeds germinating from a greater depth, such as red root.

LIST OF WEEDS LARGELY CONTROLLED BY NORMAL RATES OF HORMONE WEEDKILLERS

(For details see Section 2)

Common Name	Botanical Name	Common Name	Botanical Name
Alligator weed	<i>Telanthera phloxeroides</i>	Californian thistle	<i>Cirsium arvense</i>
Apple of Peru	<i>Nicandra physaloides</i>	Cape tulip	<i>Homeria collina</i>
Apple of Sodom	<i>Solanum sodomaeum</i>	Cape weed	<i>Cryptostemma calandulacea</i>
Australian flax	<i>Linum marginale</i>	Catchfly	<i>Silene gallica</i>
Australian fireweed	<i>Erechtites atkinsoniae</i>	Catsear	<i>Hypochaeris radicata</i>
Barberry	<i>Berberis vulgaris</i>	Chamomile	<i>Matricaria chamomilla</i>
Bathurst burr	<i>Xanthium spinosum</i>	Charlock	<i>Sinapis arvensis</i>
Beaked parsley	<i>Anthriscus vulgaris</i>	Chickweed	<i>Stellaria media</i>
Bidi bidi or pipiriri	<i>Acaena</i> spp.	Cleavers	<i>Galium aparine</i>
Blackberry	<i>Rubus</i> spp.	Convolvulus or bindweed	<i>Convolvulus arvensis</i>
Black medick	<i>Medicago lupulina</i>	White bindweed or greater bindweed	<i>Calystegia sepium</i>
Black nightshade	<i>Solanum nigrum</i>	Cornbind or black bindweed	<i>Polygonum convolvulus</i>
Bladder campion	<i>Silene cucubalus</i>	Cotton thistle	<i>Onopordon acanthium</i>
Bracken fern	<i>Pteridium esculentum</i>	Creeping mallow	<i>Modiola caroliniana</i>
Broom	<i>Cytisus monspessulanus</i>	Cudweed	<i>Gnaphalium luteo-album</i>
Broom, Scotch	<i>C. scoparius</i>	Curnow's curse	<i>Calandrinia caulescens</i>
Burdock	<i>Arcium lappa</i>	Cut-leaved geranium	<i>Geranium dissectum</i>
Burr clover	<i>Medicago arabica</i> or <i>M. hispida</i>		
Buttercups	<i>Ranunculus</i> spp.		

Common Name	Botanical Name	Common Name	Botanical Name
Daisy	<i>Bellis perennis</i>	Shepherd's purse	<i>Capsella bursa-pastoris</i>
Dandelion	<i>Taraxacum officinale</i>	Silver poplar	<i>Populus alba</i> var. <i>nivea</i>
Docks—		Sow thistle	<i>Sonchus oleraceus</i>
Broad-leaved	<i>Rumex obtusifolius</i>	Spanish heath	<i>Erica lusitanica</i>
Curled	<i>R. crispus</i>	Speedwell	<i>Veronica arvensis</i>
Fiddle	<i>R. pulcher</i>	Spider wort or Hima-	
Dove's foot	<i>Geranium molle</i>	layan honeysuckle	<i>Leycesteria formosa</i>
Fat-hen	<i>Chenopodium album</i>	Spurrey	<i>Spergula arvensis</i>
	<i>C. pumilio</i>	Spur valerian	<i>Kentranthus ruber</i>
Fennel	<i>Foeniculum vulgare</i>	St. John's wort	<i>Hypericum perforatum</i>
Field chickweed	<i>Cerastium arvense</i>	Staggerweed	<i>Stachys arvensis</i>
Field horsetail	<i>Equisetum arvense</i>	Stinging nettle	<i>Urtica dioica</i>
Fleabane	<i>Erigeron crispus</i>	Stinking mayweed	<i>Anthemis cotula</i>
Fleabane Canadian	<i>E. canadensis</i>	Storksbill	<i>Erodium cicutarium</i>
Foxglove	<i>Digitalis purpurea</i>	Subterranean clover	<i>Trifolium subterraneum</i>
Fumitory	<i>Fumaria muralis</i>	Suckling clover	<i>Trifolium dubium</i>
Goat's rue	<i>Galega officinalis</i>	Sweet brier	<i>Rosa eglanteria</i>
Gorse	<i>Ulex europaeus</i>	Tansy	<i>Tanacetum vulgare</i>
Groundsel	<i>Senecio vulgaris</i>	Tarweed	<i>Odontites viscosa</i>
Hard fern	<i>Paesia scaberula</i>	Tauhinu	<i>Pomaderris phyllocafolia</i>
Hawkbit	<i>Leontodon leysleri</i>	Tauhinu-korokio	<i>Cassinia leptophylla</i>
Hawkweed	<i>Crepis capillaris</i>	Teasel	<i>Dipsacus silvester</i>
Hedge mustard	<i>Sisymbrium officinale</i>	Thorn apple	<i>Datura stramonium</i>
Hemlock	<i>Conium maculatum</i>	Toad rush	<i>Juncus bufonius</i>
Hoary cress	<i>Cardaria draba</i>	Tutsan	<i>Hypericum androsaemum</i>
Horehound	<i>Marrubium vulgare</i>	Tutu	<i>Coriaria</i> spp.
Horse radish	<i>Cochlearia armoracia</i>	Twin cress or	<i>Coronopus didymus</i>
<i>Hydrocotyle</i> spp.		land cress	
Inkweed	<i>Phytolacca octandra</i>	Variegated thistle	<i>Silybum marianum</i>
Lupin	<i>Lupinus arboreus</i>	Vetch	<i>Vicia sativa</i>
Mallow	<i>Malva parviflora</i>	Water cress	<i>Nasturtium officinale</i>
Manuka, white	<i>Leptospermum scoparium</i>	Water hyacinth	<i>Eichhornia crassipes</i>
Kanuka	<i>L. oricoides</i>	White clover	<i>Trifolium repens</i>
Marshmallow	<i>Althaea officinalis</i>	White dead nettle	<i>Lamium album</i>
Matagouri	<i>Discaria toumatou</i>	Wild garlic	<i>Allium vineale</i>
Mexican devil weed	<i>Eupatorium adenophorum</i>	Wild mignonette	<i>Reseda luteola</i>
Mint	<i>Mentha</i> spp.	Wild onion	<i>Allium triquetrum</i>
Monkey musk	<i>Mimulus guttatus</i>	Wild parsnip	<i>Pastinaca sativa</i>
Mouse-eared chick-		Wild Spaniard	<i>Aciphylla squarrosa</i>
weed	<i>Cerastium glomeratum</i>	Wild turnip	<i>Brassica campestris</i>
Mouse-ear hawkweed	<i>Hieracium pilosella</i>	Willows	<i>Salix</i> spp.
Musky storksbill	<i>Erodium moschatum</i>	Willow herb	<i>Epilobium</i> spp.
<i>Muehlenbeckia</i>		Winged thistle	<i>Carduus tenuiflorus</i>
<i>australis</i>		Wire weed	<i>Polygonum aviculare</i>
<i>Nertera dichondrae-</i>		Wood sage	<i>Teucrium scorodonia</i>
<i>folia</i>		Yarrow	<i>Achillea millefolium</i>
New Zealand flax	<i>Phormium tenax</i>	Yellow gromwell	<i>Amsinckia angustifolia</i>
Nodding thistle	<i>Carduus nutans</i>	Yellow weed	<i>Galinsoga parviflora</i>
Nutgrass	<i>Cyperus rotundus</i>		
Onehunga weed	<i>Soliva sessilis</i>		
	<i>S. valdiviana</i>		
Oxalis	<i>Oxalis</i> spp.		
Ox-eye daisy	<i>Chrysanthemum</i>		
	<i>leucanthemum</i>		
Ox-tongue	<i>Helminthia echinoides</i>		
Parsley dropwort	<i>Oenanthe pimpinelloides</i>		
Pearwort	<i>Sagina procumbens</i>		
Pennycroyal	<i>Mentha pulegium</i>		
Periwinkle	<i>Vinca major</i>		
Plantain	<i>Plantago</i> spp.		
Purslane	<i>Portulaca oleracea</i>		
Ragwort	<i>Senecio jacobaea</i>		
Raupe	<i>Typha angustifolia</i>		
Red clover	<i>Trifolium pratense</i>		
Red dead nettle	<i>Lamium purpureum</i>		
Red root	<i>Amaranthus retroflexus</i>		
Red shank or			
willow weed	<i>Polygonum persicaria</i>		
Rushes	<i>Juncus</i> spp.		
Russian knapweed	<i>Centaurea repens</i>		
Saffron thistle	<i>Carthamus lanatus</i>		
Scarlet pimpernel	<i>Anagallis arvensis</i>		
Scotch thistle	<i>Cirsium lanceolatum</i>		
Self heal	<i>Prunella vulgaris</i>		
Sheep's sorrel	<i>Rumex acetosella</i>		

List of crops effectively weeded by hormone weedkillers:—Wheat, barley, oats, maize, potatoes.

Weedkillers Derived from Hormone Weedkiller Base

Selective compounds that have little or no action on the foliage of plants can be made from M.C.P., 2,4-D, and 2,4,5-T base; these compounds are only activated when applied to the soil. The soil must be moist at the time of application and rainfall should preferably follow the application. These materials are very selective and will control only germinating seeds of small-seeded weeds. The most susceptible weeds are those that germinate near the surface of the ground.

The period these compounds remain effective in the soil is relatively short,

depending on soil type, rainfall, soil temperature, etc. Materials derived from 2,4,5-T base such as Natriin (sodium salt of 2,4,5-trichlorophenoxyethyl sulphate) persist the longest and may remain active for 4 to 6 weeks. Compounds based on 2,4-D such as SES (sodium salt of 2,4-dichlorophenoxyethyl sulphate) have a shorter residual life than the same preparation based on 2,4,5-T. It remains active for a period of 1 to 2 weeks. A similar preparation Sesin also based on 2,4-D (2,4-dichlorophenoxyethyl benzoate) is less soluble than SES and hence has longer residual properties in the soil.

The rates of application normally employed are 2lb. to 4lb. for mineral soils and 4lb. to 6lb. for organic soils. Crops most effectively weeded with these chemicals are large-seeded crops planted deeply such as maize, potatoes, asparagus, and bulbs such as gladioli. These preparations are also useful for weeding established row crops such as strawberries. Much further work is required to develop these compounds to their fullest use in New Zealand.

Phenols

The term phenols is employed to cover a range of preparations that have a wide field of use. The phenols, unlike the hormone preparations, are true contact killers or plant poisons, that is, they affect only that part of the plant contacted by the chemical, and there is little or no movement of the chemicals in the plant. Spray cover to be effective must be applied to wet the weeds thoroughly and be distributed evenly over the whole plant. Phenols are protein coagulants and therefore react more quickly and with greater toxicity under higher temperatures. Their chief disadvantage is that they are poisonous to the user and must be handled with care and applied with suitable equipment.

The parent phenols are soluble in oil and are non-selective contact killers. The salts of the phenols, however, are water soluble and are employed as selective contact killers.

Phenol preparations are of the following types:—

P.C.P. (pentachlorophenol), D.N.O.C. (dinitro-o-cresol), D.N.B.P. (dinitro-ortho-secondary butyl phenate), and mixtures of D.N.B.P. and D.N.A.P.

(dinitro-ortho-secondary amyl phenate). Preparations of P.C.P. are of two types. The sodium salt of pentachlorophenate is water soluble and can be employed for selective weed control; preparations of pentachlorophenol fortified with aromatic oil or creosote are formulated as emulsifiable concentrates and can be employed as non-selective contact killers. Preparations of D.N.O.C. (namely the sodium salt) were available in New Zealand in the past, but have been replaced by the D.N.B.P. formulations. The disadvantages of the sodium salt of D.N.O.C. were that it required activation with acid salt such as sulphate of ammonia, was less soluble than the D.N.B.P. preparations, and showed less activity than D.N.B.P. Amine salt preparations of D.N.O.C. have been employed in trial work in New Zealand. This compound has the advantage of being more soluble, does not require activation by an acid salt, and is less hazardous to employ. Its chief disadvantage is that it is more subject to adverse weather conditions than the sodium salt preparations and also less selective than D.N.B.P. preparations.

Preparations of D.N.B.P. are the most important phenol materials. Four types of these preparations are available.

Ammonium salt of D.N.B.P., a water soluble preparation used for the selective control of weeds in leguminous crops such as peas and lucerne.

Amine salts of D.N.B.P., water soluble materials that can be used for pre-emergence weed control or for post-emergence weed control. If used for post-emergence weed control, it has the disadvantage of being more subject to adverse weather conditions than the ammonium salt preparations.

Parent D.N.B.P., insoluble in water but soluble in aromatic oils such as diesel fuel oil. If the material is first dissolved in an aromatic oil, it can then be emulsified with water. This material is employed for non-selective weed control such as contact pre-emergence control of weeds in small fruits and as a crop desiccant.

Mixtures of parent D.N.B.P. and D.N.A.P. These materials have the same properties as the parent D.N.B.P. preparation, but show a wider range of selectivity.



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There is a Stantox product for your particular weed problem—whatever it may be.

Stantox T-45S kills gorse, broom, blackberry, goat's rue, lupin, briar, etc.

Stantox 64 kills weeds infesting wheat, oats, barley and similar crops.

Stantox P-44 kills thistles, ragwort, buttercup (not giant buttercup), stinging nettle, rushes, fennel, convulvulus, hemlock and other pasture weeds.

Stantox TCA-90 kills couch, Kikuyu (Paspalum, tall fescue as seedlings only), and weeds in swedes, rape and turnips.

Stantox CMU controls most annual and perennial weeds for an extended period on non-crop land such as yards, paths, draining ditches, plant sites.

Stantox IPC and **Chlor IPC** controls germinating grasses and some broad-leaved weeds in crops. Recommended for lucerne, onions, carrots, etc.

Stantox MCP-30 kills weeds in maize, sweet corn, wheat, etc., and is especially recommended for the control of giant buttercup. **Stantox Dock Killer** clears docks from pastures.

Sinox W kills weeds infesting peas and lucerne.

Sinox General for pre-harvest and defoliation of all seed clovers and potatoes, and is a safe weed killer for small fruits and orchards.

Stantox and Sinox Weed Killers are produced under strict control. Extreme care at every stage of manufacture ensures that there is not the slightest variation from the approved Stantox and Sinox formulas. And to guarantee that quality Stantox and Sinox Weed Killers are packed in sealed cans. Whenever you buy Stantox or Sinox you get the certified full strength product. That alone is a good reason for always insisting on Stantox and Sinox.



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Table 2 lists the phenol preparations available in New Zealand. The phenol equivalent is that stated by the manufacturers. Recently a standard method of analysis has been adopted in England and the phenol equivalent given in the table may have to be reduced in some cases, for example, Sevtox formerly listed as 2.0lb. per gallon is known to have a phenol equivalent of 1.7lb. per gallon when based on the standard method of analysis.

Methods of application: In post-emergence applications the phenols are used in two ways. The selective water soluble forms of D.N.B.P. are applied directly to the crop. The application should be made when the weeds are young and the crop is dry and hardened by 2 or 3 days of fine weather. A sufficient quantity of water should be employed to wet the weeds thoroughly, but excessive run-off should be avoided. Atomisation of the spray particles should also be avoided as this decreases the selectivity of the preparation and crop damage may result. The quantity of active principle applied depends on the prevailing temperature and moisture conditions prior to spraying. The temperatures should preferably be not lower than 60 degrees F. or above 80 degrees F. at the time of application. A smaller quantity of material should be employed as the temperature range increases, for example, if a 1lb. rate is employed at temperatures of 60 to 70 degrees F., then 0.75lb. of material would be sufficient for temperatures between 70 and 80 degrees F.

Those weeds most effectively destroyed by this type of application are soft succulent seedlings 2in. to 4in. high, such as wild turnip. Weeds with a waxy leaf are either resistant or killed only at the seed leaf stage, for example, cleavers.

The insoluble forms are activated with aromatic oils or emulsified with aromatic oils and water and applied as a direct spray for weed control on paths in nurseries and for the control of weeds in small fruits. Excellent control of plants arising from seeds is obtained. Regrowth plants are checked and repeat applications are necessary for their control. Provided spray drift does not occur, these materials can be

used with comparative safety in nurseries containing susceptible plants. For weed control in small fruits the area can be sprayed up to the bases of the plants, but the spray should be directed so that the material does not come into contact with the plants.

Parent phenols when used for pre-emergence applications for the control of weeds in large-seeded crops such as peas, maize, etc., and bulbs are regarded as contact pre-emergence chemicals. Unlike the hormone weedkillers, there is little residual effect of the phenols in the soil. The phenols are quickly broken down by soil bacteria and by volatilisation and hence are much more selective than hormone weedkillers. If they are used in this way, excellent control of most germinating seeds is obtained. Plants arising from regrowth such as Californian thistle are checked, but soon recover and control is normally poor.

The following weeds are effectively checked or killed by the post-emergence applications of salts of phenols, depending on the weed, from the seed leaf stage to 4in. high, at normal rates of application. For details see Section 2.

Apple of Peru	<i>Nicandra physaloides</i>
Black nightshade	<i>Solanum nigrum</i>
Bladder campion	<i>Silene cucubatus</i>
Capeweed	<i>Cryptostemma</i> <i>calendulacea</i>
Catchfly	<i>Silene gallica</i>
Catsear	<i>Hypochaeris radicata</i>
Charlock	<i>Sinapis arvensis</i>
Chickweed	<i>Stellaria media</i>
Cleavers	<i>Galium aparine</i>
Cornbind	<i>Polygonum convolvulus</i>
Docks	<i>Rumex</i> spp.
Fat-hen	<i>Chenopodium album</i>
Field chickweed	<i>Cerastium arvense</i>
Fumitory	<i>Fumaria muralis</i>
Hedge mustard	<i>Sisymbrium officinale</i>
Hoary cress	<i>Cardaria draba</i>
(Only plants developing from seeds)	
Mouse-eared chick-weed	<i>Cerastium glomeratum</i>
Red dead nettle	<i>Lamium purpureum</i>
Red root	<i>Amaranthus retroflexus</i>
Red shank	<i>Polygonum persicaria</i>
Scarlet pimpernel	<i>Anagallis arvensis</i>
Scotch thistle	<i>Cirsium lanceolatum</i>
Shepherd's purse	<i>Capsella bursa-pastoris</i>
Sow thistle	<i>Sonchus oleraceus</i>
Speedwell	<i>Veronica arvensis</i>
Spurrey	<i>Spergula arvensis</i>
Staggerweed	<i>Stachys arvensis</i>
Stinging nettle	<i>Urtica dioica</i>
Stinking mayweed	<i>Anthemis cotula</i>
Twin cress or land cress	<i>Coronopus didymus</i>
White dead nettle	<i>Lamium album</i>
Wild turnip	<i>Brassica campestris</i>
Wireweed	<i>Polygonum aviculare</i>

TABLE 2—PHENOL PREPARATIONS

Type	Formulation	Trade name	Active principle lb.	Form of weedkiller
D.N.B.P.	Ammonium salt	Sevtox	2.0	water soluble
		Sinox W	2.0	water soluble
		Plant Protection D.N.B.P.	2.0	water soluble
		Yates Reliable D.N.B.P.	2.0	water soluble
		Dow Selective Weedkiller	1.3	water soluble
D.N.B.P.	Parent Phenol	Sinox PE	3.0	oil soluble
D.N.B.P.	Parent Phenol	Sinox General	5.0	oil soluble
D.N.A.P.			1.0	
P.C.P.	Sodium salt	Weedone P.C.P.	2.0	water soluble
D.N.O.C.— No longer available commercially				

List of crops tolerant to post-emergence applications of salts of phenols 1lb. to 2lb.:—

Leguminous crops such as white clover, red clover, lucerne, peas, and beans and established grass crops and cereals.

As pre-emergence treatments at rates of 2lb. to 4lb.

Maize, potatoes, and asparagus and most bulbous crops.

T.C.A.

T.C.A. is the abbreviated term for trichloroacetic acid. The most usual formulation is the sodium salt of T.C.A. (sodium salt of trichloroacetic acid). This chemical could be labelled a selective grass killing preparation, but when applied to the soil it has given control of germinating seeds of broad-leaved plants such as red shank, red root, etc.

This material is available in New Zealand under various proprietary names. It is usually sold at a 90 per cent. strength with an acid equivalent of 79.3 per cent. This being the case all recommendations will be given in terms of one pound of the material and not in terms of acid equivalents. The acid equivalent can be calculated by reducing pounds of T.C.A. by the ratio of 79.3 : 100.

Physical Properties

T.C.A. is a white powder that must be stored in water-tight bags; otherwise it absorbs atmospheric water and decomposes, losing its herbicidal activity. When this occurs it forms a solid of low herbicidal activity. T.C.A. is readily soluble in water and this is the usual method of distribution, though it can be applied with fertilisers. It is slightly corrosive to equipment and should not be left standing in equipment and all equipment should be washed in water after use. It has a caustic action and is slightly irritating to the skin and should not be handled with bare hands or applied at the post-emergence stage to seedling crops.

Factors Affecting the Efficiency of T.C.A.

Rainfall: T.C.A. has little herbicidal action on the foliage of grasses; its main action is through the roots of plants. If applied to the foliage of plants, it must be washed down into the root zone, hence rainfall is essential for the efficiency of this material. Applications should be made when the soil is moist and preferably immediately prior to rainfall. Up to $\frac{1}{2}$ in. of rain is required for light sandy soils and 1 in. or so for heavy soils. If the application is made and no rainfall follows, the T.C.A. will break down over several weeks, depending on the

amount of moisture in the air, and give poor weed control.

Soil type: Provided leaching does not take place too rapidly, T.C.A. is usually more effective in light sandy soils than on soils high in clay content. The rate of application should be increased by 5lb. to 10lb. for weed control in heavy clay soils. T.C.A. also persists much longer in clay soils than light sandy soils under the same rainfall. In porous soils like the light volcanic soils of Auckland T.C.A. is not effective; it is leached too readily. This also applies to railway lines where the ballast is relatively thick. Soils high in humus content require a higher rate of application than soils low in humus content. At normal rates of application the residual effect of T.C.A. in soils is gone after 4 to 6 weeks.

Cultivation: The most efficient method of applying T.C.A. is directly to the soil. The rates of application can be reduced considerably if the material is applied directly to the soil. Very low rates are required to control germinating seedling grasses and cultivation activates root growth of couch or twitch-like (rhizomatous) grasses, thus increasing the susceptibility. The grasses must be growing actively at the time of application. Other methods of promoting growth where cultivation is not possible are by burning or cutting to remove the top growth. The grasses should then be treated when regrowth occurs.

Growth type of weeds: Germinating annual and perennial grasses are readily killed by T.C.A. Most annual grasses such as barley grass can be killed with fairly low rates of T.C.A. Of the perennial grasses the rhizomatous (couch and twitch-like) grasses are normally the most readily killed. Stoloniferous grasses such as kikuyu are usually intermediate in tolerance and the established fibrous rooted grasses are very difficult to kill and often require repeated applications for control. This chemical cannot be recommended for the control of some types of established fibrous rooted grasses.

Rates of application: The rates of application depend on many variable factors such as soil type, method used to activate grass growth, etc., so that

rates should be based on local knowledge. Table 3 indicates the rates of application necessary under varying conditions.

Method of use: The chief use of T.C.A. is for the selective control of germinating grass weeds in crops or the eradication of rhizomatous grasses in conjunction with cultivation and cropping. Crops such as brassicas, potatoes, etc., tolerate up to 20lb. to 30lb. of T.C.A. applied at pre-emergence. Germinating annual grasses are kept out of T.C.A.-tolerant crops by applying T.C.A. immediately the crop is sown, when the soil is moist and rain is expected. Rhizomatous grasses such as couch or twitch are effectively controlled by ploughing, rotary hoeing, or discing, sowing a T.C.A.-tolerant crop, and treating the area immediately with up to 20lb. to 30lb. of T.C.A. The cultivation activates the grass growth, making it more susceptible to T.C.A. The smothering effect of the crop combined with the effect of the T.C.A. is usually sufficient to secure a high degree of grass control. The cultivation required to prepare the ground for further cropping or sowing down into pasture is usually sufficient to give complete eradication. Disappointing results occur if no follow-up treatment is made after the initial application of T.C.A. Complete control is not secured with one application and if a small percentage of viable rhizomes are left after the toxicity of the T.C.A. is worn off in the soil, then the area is quickly reinfested. Follow-up treatments must be made for good results, whether by cultivation or further applications of T.C.A.

The normal method of cultivating couch areas by hustling is not satisfactory if T.C.A. is to be employed. The T.C.A. fails to gain entry into the large root-bound sods and these act as a further area of infestation. The rhizomes should be broken up and chopped into short pieces by discing or rotary hoeing. Couch eradication has only proved satisfactory where rainfall has followed the application to activate the T.C.A. and promote couch growth.

Applied at pre-emergence under favourable conditions, T.C.A. will also control many broad-leaved weeds and

TABLE 3—RATES OF APPLICATION OF T.C.A.

Type of weed	Method of application	Rates per ac./lb.
Germinating annual and perennial seedlings	Top of soil after cultivation	5 to 15
	Without cultivation	10 to 15
Established annuals	On new growth	15 to 25
Rhizomatous perennials .. (established) .. .	After cultivation .. .	25 to 40
	After mowing, burning, etc.	30 to 50
	On rank growth .. .	40 to 60
Fibrous rooted perennials (established) .. .	After mowing, burning, etc.	60 to 80
	Some species only .. .	80. to 100

offers a satisfactory method of weed control in such crops as brassicas.

Precautions in the Use of T.C.A.

T.C.A. should not be used in the root areas of trees, shrubs and hedges, and ornamental plants. It is very doubtful if T.C.A. could kill established broad-leaved plants at the normal rate of application, but malformation of the growing tips and the loss of production in the case of fruit trees occur through its use. Not sufficient information is known on the susceptibility of various broad-leaved plants to make any recommendations. For deciduous species applications of T.C.A. are safe enough, if applied in the middle of the dormant season.

The following is a list of weeds which have been checked or killed by applications of T.C.A. at normal rates of application. For details see Section 2.

Grasses, Sedges, and Rushes

Barnyard grass	<i>Echinochloa crusgalli</i>
Barley grass	<i>Hordeum murinum</i>
Browntop	<i>Agrostis tenuis</i>
Cocksfoot	<i>Dactylis glomerata</i>
(In establishment stages only)	
Crab grass	<i>Digitaria sanguinalis</i>
Creeping fog	<i>Holcus mollis</i>
Creeping bent	<i>Agrostis stolonifera</i>
Floating sweet grass	<i>Glyceria fluitans</i>
Hairgrass	<i>Vulpia dertonensis</i>
English hairgrass	<i>Aira</i> spp.
Kangaroo grass	<i>Themeda triandra</i>
(Establishment stages only)	
Kentucky bluegrass	<i>Poa pratensis</i>
Kikuyu	<i>Pennisetum clandestinum</i>
Indian doub	<i>Cynodon dactylon</i>
Manchurian wild rice	<i>Zizania latifolia</i>
(Not satisfactory)	
Nassella tussock	<i>Nassella trichotoma</i>
Nigger head	<i>Mariscus uticulatus</i>
(Very high rates)	
Nutgrass	<i>Cyperus rotundus</i>

"Old-man" twitch *Agropyron repens*
Onion rooted twitch *Arrhenatherum elatius*
var. *bulbosom*

Paspalum dilatatum
(Only as establishing plants)

Paspalum distichum
Pennisetum

macrourum
(Only at very high rates)

Poa annua

Prairie grass *Bromus catharticus*
(Only as establishing plants)

Rough stalked

meadow grass

Ryegrass, perennial

Ryegrass, Italian

Ryegrass, short-rotation

Poa trivialis

Lolium perenne

L. multiflorum

L. hybrid spp.

Carex lucida

Carex ternaria var.

gracilis

Carex comans

Carex longifolia

(Control not satisfactory)

Sweet vernal

Tall fescue

(Only as establishing plants)

Timothy

Toad rush

Yorkshire fog

Anthoxanthum odoratum

Festuca arundinacea

Phleum pratense

Juncus bufonius

Holcus lanatus

Polygonum convolvulus

Chenopodium album

Amaranthus retroflexus

Polygonum persicaria

Polygonum aviculare

Polygonum aviculare

Polygonum aviculare

Polygonum aviculare

Polygonum aviculare

Polygonum aviculare

Polygonum aviculare

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Polygonum aviculare

Polygonum aviculare

Polygonum aviculare

Polygonum aviculare

List of broad-leaved weeds effectively checked or killed by pre-emergence applications of 5lb. to 20lb.

Cornbind	<i>Polygonum convolvulus</i>
Fat-hen	<i>Chenopodium album</i>
Red root	<i>Amaranthus retroflexus</i>
Red shank	<i>Polygonum persicaria</i>
Wireweed	<i>Polygonum aviculare</i>

List of crop tolerances to treatments applied at pre-emergence.

Tolerant crops (not damaged by rates up to 20lb.): Cruciferous (turnips, swedes, etc.), carrots, celery, parsnips, beet, flax, peas, and potatoes.

Intermediate crops (not damaged by rates up to 10lb.): Asparagus, onions, strawberries, lucerne, white clover, red

clover, and bulbs and corms such as narcissi and gladioli.

Dalapon

Chemically Dalapon is α,α -dichloropropionic acid or 2,2-dichloropropionic acid. It is formulated as the sodium salt of the above acid. Dalapon is a recently introduced chemical and very few trials have been conducted with it to date. Much further work is required with this interesting compound. Dalapon may be classified as a grass killer that may be largely selective, though its effect on most broad-leaved species is not known. Unlike T.C.A., which exerts its maximum toxicity through the roots of plants, Dalapon acts largely through the foliage of plants. The formulation has been 78 per cent. active or 68 per cent. acid equivalent, but more recently a preparation 85 per cent. active has become available. Any recommendation is given in terms of pounds of Dalapon and this needs to be reduced by the ratio of 68:100 to obtain the true acid equivalent.

Physical Properties

Dalapon is a tan-white free-flowing powder that is readily soluble in water and must be stored in water-tight bags; otherwise it absorbs atmospheric water and decomposes, losing its herbicidal activity. Water solutions of Dalapon also should not be stored for any length of time, as these may also break down.

Factors Affecting the Efficiency of Dalapon

The same factors apply here as for hormone weedkillers, etc. The plants must be growing vigorously and the material should be applied to fresh green growth. Poor results have been obtained where the material has been applied to dried-up grass growth. If necessary, the growth of the grass should be invigorated by cutting or burning and the fresh regrowth sprayed.

If rain falls immediately after the application, the material is largely washed off the leaves and poorer control will be obtained. Several days of fine weather should preferably follow the application.

Precautions in the Use of Dalapon

The effect of Dalapon on desirable woody species is not known. This chemical is probably very useful for the control of grasses adjacent to shrubs of value, provided rain does not fall after the application so that the material is washed into the soil. If this occurs, damage has been noted on some woody perennials.

Growth Type of Weeds

Preliminary work indicates that most grasses germinating from seed are susceptible to Dalapon. Fibrous rooted grasses such as tall fescue, etc., are probably more readily killed with Dalapon than rhizomatous grasses such as "old-man" twitch.

The following plants have been checked and killed by rates of Dalapon of 20lb. to 50lb. in initial trial work. For details see Section 2.

Cocksfoot	<i>Dactylis glomerata</i>
Crab grass	<i>Digitaria sanguinalis</i>
Hair grass	<i>Vulpia dertonensis</i>
Sweet vernal	<i>Anthoxanthum</i>
	<i>odoratum</i>
Yorkshire fog	<i>Holcus lanatus</i>

Crop Tolerance

Initial work indicates that low rates of 2lb. to 4lb. do not damage lucerne or swede crops.

Carbamates

The two well-known chemicals here are I.P.C. (isopropyl-n-phenyl carbamate) and C.I.P.C. (isopropyl-N-(3-chlorophenyl) carbamate). I.P.C. could be labelled as a selective grass weed-killer, but when applied directly to the soil it has given good control of broad-leaved species such as spurrey. C.I.P.C. effectively controls some grasses and a wide range of broad-leaved species.

Both the above materials are available in New Zealand; they are listed in Table 4. I.P.C. is available as a 50 per cent. powder and C.I.P.C. as an emulsified concentrate containing 4lb. of carbamate equivalent. All recommendations are given in terms of the carbamate equivalent.

Physical Properties

I.P.C. is a white powder largely insoluble in water, but can be dispersed in water. It does not form a

TABLE 4 — CARBAMATES

Type	Formulation	Trade name	Acid equivalent	Form of weedkiller
I.P.C.	isopropyl ester	Stantox I.P.C. 50	0.5lb. per lb. of dust	Wettable powder
C.I.P.C.	isopropyl ester	Stantox Chloro-I.P.C. 47	4.0lb. per gallon	Oil soluble
		Weedone Chloro-I.P.C.	4.0lb. per gallon	Oil soluble

true solution, but forms a suspension that should be kept agitated when being dispersed. C.I.P.C. is usually available as an emulsifiable concentrate that can be dispersed readily with water. Neither material has any disagreeable properties, but some of the solvents used in the formulation of C.I.P.C. have a strong contact action on the foliage of plants and hence this material should not be applied directly to the foliage of the germinating seed crops without prior testing.

Factors Affecting the Efficiency of I.P.C. and C.I.P.C.

As both these chemicals give the most efficient control of weeds at the germination stage, their most suitable method of application is directly to the soil. The soil should be moist at the time of application and rain should preferably follow the application. Under New Zealand conditions C.I.P.C. in particular has worked more effectively than T.C.A. under drier conditions and this chemical should be used in preference to T.C.A. under drier conditions.

Soil type: Both I.P.C. and C.I.P.C. under cool soil temperatures have a longer residual life than T.C.A. C.I.P.C. has a longer residual action than I.P.C. Both chemicals appear more effective on light soils than on heavy organic soils. Unlike T.C.A. both I.P.C. and C.I.P.C. disappear more quickly by volatilising away than by leaching. As with T.C.A. leaching is more rapid on light sandy soils than on heavy organic soils.

Method of application: Both I.P.C. and C.I.P.C. are selective preparations and give the best control when the

weed seeds are just germinating and the radicle (embryo root) is up to lin. to 2in. long; hence these materials should be applied directly to the soil immediately after cultivation. Their greatest value is for weed control in crops; hence the chemical should be applied immediately the crop is sown. The crop should be sown immediately after cultivation.

Rates of application: Applied directly to the soil rates of 1lb. to 2lb. of I.P.C. and C.I.P.C. are normally adequate. For seedling grass control rates of 2lb. to 4lb. of I.P.C. and C.I.P.C. are required. The control of broad-leaved species is not good once the broad-leaved weeds have established above an inch or so high at rates of 2lb. to 4lb. A few species of established perennial grasses such as browntop have been killed by amounts of 8lb. to 12lb. of I.P.C., but it cannot be recommended for control of established perennial grasses.

The following grasses have been effectively controlled as germinating seedlings under suitable conditions by normal rates of I.P.C. and C.I.P.C. For control of grasses only, I.P.C. should be used in preference to C.I.P.C. at 2lb. to 4lb. For details see Section 2.

Barnyard grass	<i>Echinochloa crusgalli</i>
Barley grass	<i>Hordeum murinum</i>
Browntop	<i>Agrostis tenuis</i>
Cocksfoot	<i>Dactylis glomerata</i>
Crab grass	<i>Digitaria sanguinalis</i>
Kentucky blue grass	<i>Poa pratensis</i>
<i>Poa annua</i>	
Ryegrass	<i>Lolium</i> spp.
Sweet vernal	<i>Anthoxanthum odoratum</i>
Timothy	<i>Phleum pratense</i>
Toad rush	<i>Juncus bufonius</i>
Yorkshire fog	<i>Holcus lanatus</i>



C.M.U.-treated plot a year after application. The 40lb. and 80lb. plot is still free of all vegetation. The surrounding areas were treated with high rates of proprietary materials based on borax and sodium chlorate.

Broad-leaved weeds that have been effectively destroyed by pre-emergence applications of C.I.P.C. at rates of 2lb. to 4lb. unless otherwise indicated are given below. For details see Section 2.

Black nightshade	<i>Solanum nigrum</i>
Chickweed	<i>Stellaria media</i>
Cornbind	<i>Polygonum convolvulus</i>
Docks	<i>Rumex</i> spp.
Fat-hen	<i>Chenopodium album</i> (At rates over 4lb.)
Field chickweed	<i>Cerastium arvense</i>
Mouse-eared chickweed	<i>Cerastium glomeratum</i>
Red dead nettle	<i>Lamium purpureum</i>
Red root	<i>Amaranthus retroflexus</i> (At rates over 4lb.)
Red shank	<i>Polygonum persicaria</i>
Shepherd's purse	<i>Capsella bursa-pastoris</i>
Speedwell	<i>Veronica arvensis</i> (At rates over 4lb.)
Spurrey	<i>Spergula arvensis</i> (I.P.C. satisfactory at rates over 4lb.)
Twin cress	<i>Coronopus didymus</i> (At rates over 4lb.)
Wild turnip	<i>Brassica campestris</i> (At rates over 4lb.)
Wireweed	<i>Polygonum aviculare</i>

Crops selectively treated with I.P.C. and C.I.P.C.: Leguminous crops such as clover and lucerne, and established

crops such as strawberries, leeks, lettuces, parsnips, onions, and carrots. Beets and cruciferous crops such as cabbages, swedes, turnips, etc., tolerate rates up to 1lb. Higher rates have reduced germination, particularly if soil temperature is over 60 degrees F.

Urea Compounds

The following compounds may be classified as urea compounds: D.C.U. (dichloral urea), P.M.U. (3-phenyl-1,1-dimethylurea), C.M.U. (3-(para-chlorophenyl) - 1,1 - dimethylurea) and D.C.M.U. (3-(3,4-dichlorophenyl)-1, 1-dimethylurea).

D.C.U. has been used in limited trial work only in New Zealand. It is not available commercially. Its use is limited for horticultural purposes and has shown promise for the control of grass weeds and some broad-leaved weeds such as clovers in crops such as beetroot, some crucifers, etc. It is applied at pre-emergence at rates of 5lb. to 10lb. It is a wettable powder containing 73 per cent. of dichloro-

urea and is of low solubility. For effective weed control the soil must be moist at the time of application and rain must follow the application to activate the material.

P.M.U., C.M.U., and D.C.M.U.: These three chemicals form an important group and may be considered together. The chief value of these chemicals, particularly C.M.U. and D.C.M.U., is for long-term soil sterilisation, that is, where death of vegetation is desired. At low rates of application they have given good weed control in crops such as onions, carrots, and potatoes, and in established lucerne. P.M.U. and C.M.U. are the chief chemicals used for this purpose.

Physical Properties

The urea compounds are greyish-white solids, with slight odour and low solubility. P.M.U. is the most soluble compound in water, 2300 p.p.m. dissolving at 25 degrees C.; C.M.U. is intermediate, 230 p.p.m. dissolving at the same temperature; and D.C.M.U. 42 p.p.m. at the same temperature. All urea compounds are formulated as wettable powders; hence they should be applied with coarse nozzles (strainers removed from the nozzles) and the suspension should be kept agitated to avoid the materials settling out. They are not corrosive to equipment and are easy and simple to handle and offer no danger such as volatility or fire risks.

Urea compounds have little or no effect on the foliage of vegetation; the uptake is through the roots from the soil. If applied to the soil, they are absorbed quickly, if sufficient moisture is present.

Both D.C.M.U. and C.M.U. are formulated as 80 per cent. powders.

Factors Affecting the Efficiency of Urea Compounds

Rainfall: Moisture is essential for the activation of urea compounds in the soil. The urea compounds are of low solubility and require more water than, for example, a volatile material like C.I.P.C. to become activated and be taken up by the roots. Moisture following application is essential where the urea compounds are being employed at low rates of application for selective weed control. Many plants are susceptible to low

rates as germinating seedlings, but once established require high rates of application for control. Examples are dandelion and catsear. Plants such as these establish under conditions too dry for the activation of urea compounds. Used for selective weed control in crops, the urea compounds should be applied to moist soil immediately after the crop is sown and when rainfall is expected.

The use of higher rates for soil sterilisation gives no control of the plants until adequate rainfall is available apart from a slight contact action on the foliage of the weeds. If sufficient rainfall follows the application, control of the vegetation is rapid, but if inadequate rainfall follows the application, control of the vegetation is slow and may take several weeks or, under extremely dry conditions, several months.

Soil type: As for other compounds that act through the soil the period of sterility of the urea compounds depends largely on rainfall and soil type. On light sandy soils with a rainfall of about 60in. annually C.M.U. even at rates of 80lb. per acre has not given total weed control for more than 6 months. On heavier organic soils a 40lb. rate under the same rainfall conditions is still 95 per cent. bare ground after 2 years and 80lb. rate is still totally free of vegetation. P.M.U., because of its greater solubility, has lasted for a shorter period than C.M.U. and depending on the soil type could be used more profitably for the control of deeper rooted plants such as perennial plants arising from regrowths. Initial trial work has only just begun with D.C.M.U., but it is expected this material will last longer than either of the other compounds for the same set of conditions.

The extent to which the urea compounds are leached depends on soil type and rainfall. On heavy organic soil under low rainfall C.M.U. and D.C.M.U. may not be leached more than an inch or so, but under high rainfall conditions and a lighter sandy soil leaching is comparatively rapid and to a considerable depth. These factors are important when these compounds are to be used for selective weed control of established crops such as asparagus and lucerne.

Growth Type of Weed

There is little doubt that if the urea compounds are applied at high enough concentrations, control of most types of vegetation is possible. The best control is obtained of germinating annuals and perennials, and shallow rooted perennials are more readily controlled than deeper rooted perennials. Better control of deeper rooted perennials is obtained with P.M.U. rather than with C.M.U. or D.C.M.U.

Rates of Application

For selective purpose, that is weed control in crops, rates of 1lb. to 5lb. are adequate.

For sterility of bare soil rates of 20lb. to 40lb. are usually necessary.

For the control of most types of established grasses and soft broad-leaved vegetation rates of 40lb. to 80lb. are required. A few deep rooted perennials require rates over 80lb. to the acre.

The rate of application does depend on the soil type, that is equal rates are more toxic on light soil than on heavy soil. Soils high in organic matter or colloidal content require a heavier dosage, but effects are more persistent.

Methods of Use

The most efficient way of using urea compounds for weed control in crops is to apply them directly to the soil immediately after cultivation and before the crop is sown or immediately after cultivation (where this is possible) for long-term soil sterilisation. High rates of urea compounds are required to kill established vegetation, but usually about half the rate is required to keep the soil sterile; hence it is possibly cheaper to clear vegetation mechanically, and then keep it out by soil sterilants.

For the destruction of trees and patches of sweet brier C.M.U. may be applied to the bases of the trees. Subsequent rainfall washes the C.M.U. into the root zone of the tree. For this purpose C.M.U. can either be applied as a dust preferably diluted with a carrier or sprayed on.

Dangers in the Use of Urea Compounds

Users must be warned that as C.M.U. and D.C.M.U. persist for such a long

period in the soil these chemicals should be used with care and applied at rates consistent with the job in hand. If they are used indiscriminately, soil could be rendered sterile for several years. P.M.U., C.M.U., or D.C.M.U. should not be applied in the root areas of valuable trees, as trials have shown that sufficient material can be taken up by a few roots to kill the whole tree. Further, if used at soil sterilisation rates, the materials should not be applied on slopes where excessive run-off of water occurs, as the materials can be washed laterally and harm desirable vegetation on the downward slope. In trials C.M.U. at high rates has moved laterally even on flat land.

List of broad-leaved weeds selectively killed by C.M.U. and P.M.U. at rates of 1lb. to 5lb. at the germinating stage. For details see Section 2.

Apple of Peru	<i>Nicandra physaloides</i>
Black nightshade	<i>Solanum nigrum</i>
Bladder campion	<i>Silene cucubalis</i>
Buttercup	<i>Ranunculus</i> spp.
Charlock	<i>Sinapis arvensis</i>
Chickweed	<i>Stellaria media</i>
Docks	<i>Rumex</i> spp.
Fat-hen	<i>Chenopodium album</i>
Field chickweed	<i>Cerastium arvense</i>
Hoary cress	<i>Cardaria draba</i>
(Seedlings only)	
Red clover	<i>Trifolium pratense</i>
Red dead nettle	<i>Lamium purpureum</i>
Red root	<i>Amaranthus retroflexus</i>
Red shank	<i>Polygonum persicaria</i>
Scotch thistle	<i>Cirsium lanceolatum</i>
Shepherd's purse	<i>Capsella bursa-pastoris</i>
Twin cress	<i>Coronopus didymus</i>
White clover	<i>Trifolium repens</i>
Wild turnip	<i>Brassica campestris</i>
Wireweed	<i>Polygonum aviculare</i>

List of grasses, etc., selectively killed by C.M.U. and P.M.U. at rates of 1lb. to 5lb. at the germinating stage. For details see Section 2.

Barley grass	<i>Hordeum murinum</i>
Browntop	<i>Agrostis tenuis</i>
<i>Poa annua</i>	
Ryegrass	<i>Lolium</i> spp.
Sweet vernal	<i>Anthoxanthum odoratum</i>
Timothy	<i>Phleum pratense</i>
Toad rush	<i>Juncus bufonius</i>
Yorkshire fog	<i>Holcus lanatus</i>

List of broad-leaved weeds killed in waste areas by rates of 20lb. to 80lb. of C.M.U. For details see Section 2.

Australian fireweed	<i>Erechtites atkinsoniae</i>
Barberry	<i>Berberis vulgaris</i>
Blackberry	<i>Rubus</i> spp.
Black medick	<i>Medicago lupulina</i>
Bracken fern	<i>Pteridium esculentum</i>
Burr clover	<i>Medicago hispida</i> and <i>M. arabica</i>

Californian thistle	<i>Cirsium arvense</i>
Cleavers	<i>Galium aparine</i>
Convolvulus	<i>Convolvulus arvensis</i>
Dandelion	<i>Taraxacum officinale</i>
Docks	<i>Rumex</i> spp.
Fennel	<i>Foeniculum vulgare</i>
Gorse	<i>Ulex europaeus</i>
Oxalis	<i>Oxalis</i> spp.
Plantains	<i>Plantago</i> spp.
Red clover	<i>Trifolium pratense</i>
Rushes	<i>Juncus</i> spp.
Scotch thistle	<i>Cirsium lanceolatum</i>
Sweet brier	<i>Rosa eglanteria</i>
White clover	<i>Trifolium repens</i>

List of grasses killed in waste areas by C.M.U. at rates of 20lb. to 80lb. For details see Section 2.

Browntop	<i>Agrostis tenuis</i>
Cocksfoot	<i>Dactylis glomerata</i>
Chewings fescue	<i>Festuca rubra</i> var. <i>fallax</i>
Crab grass	<i>Digitaria sanguinalis</i>
Creeping bent	<i>Agrostis stolonifera</i> var. <i>compacta</i>
Floating sweet grass	<i>Glyceria fluitans</i>
Hair grass	<i>Vulpia dertonensis</i>
Kikuyu	<i>Pennisetum clandestinum</i>
Indian doub	<i>Cynodon dactylon</i>
<i>Juncus</i> spp.	
Nutgrass	<i>Cyperus rotundus</i>
Nassella tussock	<i>Nassella trichotoma</i>
"Old-man" twitch	<i>Agropyron repens</i>
<i>Paspalum dilatatum</i>	
<i>Poa annua</i>	
Prairie grass	<i>Bromus catharticus</i>
Purua grass	<i>Scirpus maritimus</i>
Ratstail	<i>Sporobolus capensis</i>
Rough-stalked meadow grass	<i>Poa trivialis</i>
Ryegrass	<i>Lolium</i> spp.
Sedges	<i>Carex</i> spp.
Sweet vernal	<i>Anthoxanthum odoratum</i>
Tall fescue	<i>Festuca arundinacea</i>
Timothy	<i>Phleum pratense</i>
Toad rush	<i>Juncus bufonius</i>
Yorkshire fog	<i>Holcus lanatus</i>

List of crops tolerant to rates of P.M.U. and C.M.U. at 1lb. to 5lb.: Established lucerne, asparagus, onions, carrots, potatoes, and possibly maize.

Maleic Hydrazide (M.H.)

The two materials here are the diethanolamine salt of maleic hydrazide (M.H. 30) and the sodium salt of maleic hydrazide (M.H. 40). The first preparation contains 3.6lb. of M.H. equivalent per gallon and requires a wetting agent to be added for field use. The second preparation is a dust preparation containing 0.4lb. of M.H. equivalent per lb. This material has a wetting agent incorporated and is at present commercially available under proprietary trade names such as "Slow-gro" and "Malazide." It is soluble in water and is usually applied in this manner.

Possibly the main use of these materials is for sprout inhibition in crops such as potatoes, onions, and carrots. Other uses are for the slowing up of growth of hedges and lawns and for preserving cut flowers. It also holds distinct promise as a weedkiller.

Factors Affecting its Efficiency when Used as a Weedkiller

Plants must be growing vigorously and preferably young and succulent. M.H. is absorbed very slowly and fails to penetrate any plant surface that is waxy. As maximum absorption takes several days, it would be preferable if no rain fell for this period. Whenever possible the spray should be atomised as much as possible so that maximum retention of the spray particles is obtained. The inclusion of a wetting agent improves the efficiency of the amine salt preparation. The penetration of the sodium salt preparation is improved if the humidity is high after application. Conditions mentioned above are more important than rates of application. Under optimum conditions excellent control of docks has been obtained by rates of 1lb. Under adverse conditions rates as high as 6lb. have given poor results.

Use of M.H.

Initial work shows that legumes such as clovers and lucerne tolerate rates of 1lb. to 2lb. of M.H. equivalent without damage. This offers the possibilities of weeding crops such as lucerne. Docks have been controlled in such crops. M.H. is also very toxic to young grasses such as *Poa annua* and effectively controls young grasses at rates of 1lb. to 4lb. M.H. equivalent. On mature grasses that are growing vigorously rates of 1lb. to 4lb. equivalent suppress the growth of the grass rather than destroy it. The various species are affected differently; for example, browntop is more susceptible than chewings fescue. Once recovery is complete, if good growing conditions prevail, the affected grasses usually grow more quickly than untreated grasses.

After treatment with M.H. for the elimination of docks in a pasture, the grasses are usually depressed for 1 to 4 months and then completely recover.

Clover is usually not affected and continues to grow at the expense of the grasses.

If used for inhibiting grass growth, such as in lawns, M.H. is only satisfactory where the lawn is of a pure species, such as browntop. With a lawn of mixed species, if sufficient M.H. is applied to suppress the chewings fescue, death of all or part of the browntop constituent follows. If clover is present, the lawn tends to become clover dominant. There is the possibility, depending on the time of application and growing conditions, that once the grass recovers extra cutting may be necessary.

Insufficient work has been done with M.H. to present a list of species tolerance, but initial work shows that it is usually more toxic to grasses than to broad-leaved plants. It has little effect on such species as fat-hen, spurrey, chickweed, and red root, and has low toxicity to most species when applied to the soil.

Oktone

Oktone is the name given to the compound octochloro cyclohexenone. The original formulation experimented with in New Zealand was a 40 per cent. solution in a petroleum solvent. This material was oil soluble and was normally applied in diesel fuel oil under warm soil conditions or in kerosene under cool soil conditions. The latest preparation is a 90 per cent. active powder which is soluble in the above oils and should be used in the same way except that 4lb. will have to be applied to equal 1 gallon application of the original material.

Methods of Use

Oktone is a non-selective contact herbicide and gives efficient control of most germinating seedlings. The material is highly volatile and has little or no residual effect in the soil and under high soil temperatures can be applied as a pre-emergence application within a few hours of crop emergence. Under cool or cold soil temperatures the material should be applied in a lighter oil than diesel fuel oil, such as kerosene or benzine, because the diesel fuel oil persists in the soil under cool conditions and may depress the germination of the sown crop.

Other ways in which Oktone may be employed are by selective spray placement. Good weed control of paths in nurseries or between nursery stocks can be obtained with this material. Care must be taken not to apply the material on the actual nursery plants. Weeding may be done right up to the bases of nursery stocks lined out by placing a protective shield of a material such as hardboard against the nursery stock.

Where Oktone is used for post-emergence applications, fogging of spray particles should be avoided so that wind drift is minimised. This is done by using low pressures and coarse nozzles.

Advantages of Oktone

Oktone employed in a suitable aromatic carrier is a very versatile material and can be used in a pre-emergence application to almost any crop. It has the advantage of not being affected by dry weather following the application in contrast to other materials like T.C.A., I.P.C., and, to a less extent, C.I.P.C. and C.M.U. In comparison with other materials it is also non-selective to most germinating weeds; including weeds such as cress and clovers which are resistant to I.P.C. and C.I.P.C., paspalum seedlings and some flat weeds which are resistant to selective rates of C.M.U., and wild turnip and twin cress, which are resistant to T.C.A.

For farm crops such as brassicas the best method of using Oktone is by preparing a seed-bed, allowing the weeds to strike ($\frac{1}{2}$ in. to $\frac{1}{4}$ in. high), drilling in the seed, and then applying the Oktone 3 to 4 days later. Another method is to sow the seed straight after the seed-bed is prepared and then apply the Oktone a day or so before crop emergence. The first method is more suitable under dry soil conditions. The disadvantage of Oktone is that greater care is required in its application and that local conditions should be taken into account.

List of broad-leaved weeds controlled in trials to date at the germinating stage by rates of Oktone of 1 gallon (or 4lb.) in 10 to 15 gallons of diesel fuel oil:—

Black nightshade
Chickweed
Fat-hen
Hoary cress

Solanum nigrum
Stellaria media
Chenopodium album
Cardaria draba

Mouse-eared chick-weed	<i>Cerastium glomeratum</i>
Red root	<i>Amaranthus retroflexus</i>
Red shank	<i>Polygonum persicaria</i>
Shepherd's purse	<i>Capsella bursa-pastoris</i>
Speedwell	<i>Veronica arvensis</i>
Spurrey	<i>Spergula arvensis</i>
Twin cress	<i>Coronopus didymus</i>
Wild turnip	<i>Brassica campestris</i>
Wireweed	<i>Polygonum aviculare</i>

Crops that can be treated at pre-emergence with Oktone at rates up to 4lb. in a suitable area: Turnips, swedes, rape, and chou moellier and, from overseas work, other cruciferous crops, beets, and gladioli.

Endothal

Chemically, this material is disodium, 3-6 endoxo-hexahydrophthalate. It is available overseas in two formulations.

Endothal 3003: An aqueous solution containing 2.0lb. of Endothal per U.S. gallon, or 2.3lb. per Imperial gallon.

Endothal 4069: An aqueous solution containing 4lb. per U.S. gallon, or 4.8lb. per Imperial gallon of a mixture of Endothal (0.67lb. per U.S. gallon, or 0.8lb. per Imperial gallon) plus an inorganic salt, usually ammonium sulphate.

Endothal is non-corrosive to spray equipment unless left in the apparatus, is non-inflammable, and is soluble in water to 24 per cent. It is irritating to the skin and eyes and protective clothing should be worn when handling the material. It should not be mixed with chlorates or hormones (M.C.P., 2,4-D, 2,4,5-T, etc.) or oils.

Endothal 3003 is largely used for the control of weeds by pre-emergence treatments in crops such as maize, potatoes, and gladioli. The normal rate of application is 4lb. to 8lb.

Endothal 4069 is largely employed as a crop disiccant. In preliminary trial work rates of 2lb. to 8lb. have been successful for drying of maize, potatoes, and small seed crops such as clovers and lucerne. For small seeds the application of the material is usually made just when the crop is normally cut for harvesting. This has several advantages. The crop can be direct-headed instead of windrowing and harvesting and drying are not dependent on hot, dry weather. The crop

usually can be harvested several days after application. The development of aerial application work in New Zealand will greatly facilitate the use of these types of materials.

In the case of potatoes trials have shown that excessive top growth of the potatoes can be killed off. Weeds present are also destroyed so that mechanical harvesting is facilitated. Even hormone tolerant weeds such as red shank have been effectively killed by this material. Endothal can be applied to maize once the cob is fully formed. This has the advantage of cutting off the moisture supply to the cobs and the cobs dry out much quicker and hence can be harvested earlier.

Alanap-1

Chemically this material is N-1 naphthyl phthalamic acid. It is a wettable powder that is 90 per cent. active. It should be mixed thoroughly in a tank and then kept agitated while being applied. Its main action is through the soil, but if applied to the foliage of sensitive plants, it causes damage so that spray drift should be avoided if the application is being made near sensitive plants such as beets, potatoes, and spinach.

Alanap-1 has been successfully employed overseas for the control of weeds in cucumbers, squash, watermelon and pumpkins, asparagus, beans, carrots, and onions. Some varieties of squash may be injured at rates over 4lb. On light soil the normal rate of application is up to 4lb. per acre and on heavy soils up to 6lb. per acre.

Very little work has been done with Alanap-1 in New Zealand. Trials with onions and carrots showed that these crops tolerated rates up to 4lb. without injury. These rates persist in the soil from 2 to 8 weeks. The soil should be moist at the time of application and rain should preferably follow the application. Weeds such as black nightshade, twin cress, spurrey, and shepherd's purse have proved susceptible as germinating seedlings. Red shank, fat-hen, and speedwell were resistant at the same stage.

Nix

Nix is sodium isopropyl xanthate, a yellow soluble powder that acts as a

contact killer. It has little or no residual action in the soil. It is materially affected by temperature conditions and should be applied at temperatures over 70 degrees, and rain should not fall at least for 12 hours after application. As this material is strictly a contact killer, it must be applied to wet the weeds thoroughly.

It is only effective against soft succulent weeds less than an inch high. Weeds with waxy surfaces are not affected. The efficiency of the material can be increased by adding a wetting agent. This is satisfactory if the material is used as a pre-emergence application, but the addition of a wetting agent decreases the selectivity of the preparation; hence a wetting agent should not be added for post-emergence weed control. Normal rates of application are up to 8lb./ac.

Very little work has been done with this material in New Zealand. Preliminary results substantiate overseas findings that onions, asparagus, and maize can be treated at pre-emergence. Other uses overseas are for weeding cabbages, cauliflowers, brussels sprouts, broccoli, and kale when over 4in. to 5in. high. The spray should be directed at the base of the plant. Repeat applications should be made as often as required.

Weeds effectively controlled to date have been fat-hen, speedwell, and red root.

Chlorates, Borates, and Arsenicals

Chlorates, borates, and arsenicals are considered together, as they are generally regarded as non-selective weedkillers. Chlorates, largely sodium chlorate, have the distinct disadvantage of being fire hazardous. This is largely overcome by the inclusion of inert material such as calcium chloride (this product is called "Atlacide" and contains 70 per cent. sodium chlorate) or by mixing with borax such as the products "Polyborchlorate" and "Chlorax". There is some evidence that there is antagonism to the order of 10 per cent. between the chemicals if this is done.

"Polyborchlorate" contains 49 per cent. boron trioxide and 25 per cent. sodium chlorate. "Chlorax" contains 40 per cent. sodium chlorate and 58 per cent. meta-borate. Sodium chlorate has

both a contact action on the foliage of plants and is also lethal when absorbed by the roots of plants. Boron compounds have little if any contact action on the foliage of plants and act solely through the soil. "Polyborchlorate" has the double action of destroying the above-ground parts by contact action and also acting through the soil.

Ordinary borax has been employed as a weedkiller in the past, but this material is soluble enough to be leached out of the soils fairly readily and rates of up to 2000lb. secure complete sterilisation for periods of less than 6 months. It is useful for destroying oxalis in vacant lots. Other boron compounds such as Borascu (concentrated, anhydrous ordinary borax with a boron trioxide content of 61½ per cent.) at rates over 4000lb. have given complete weed control on some soils for a period of a year or more.

Arsenical preparations are on the whole more effective than equivalent rates of chlorates or borates, but possess the distinct disadvantage of being acute poisons. For this reason very little trial work has been done with this material by the Department of Agriculture in recent years and no recommendations will be made in this bulletin for its use.

Use of Materials

The main use of the above compounds is for the destruction of weeds in waste areas for a temporary or prolonged period. Preparations of sodium chlorate ("Atlacide" and to a less extent "Polyborchlorate") can be used at fairly low rates of application, 200lb. to 500lb. per acre, to kill the top growth of vegetation. Annuals are usually destroyed, but perennial plants arising from regrowths soon recover. "Atlacide" is used widely in New Zealand today for the control of railway-track weeds where a contact kill is desirable.

At higher rates of application all preparations based on sodium chlorate and boron render the soil sterile for a period. "Atlacide" at rates up to 4000lb. has let grasses come in after 6 months. Borascu in some instances at the same rate has kept the area weed free for a period exceeding one year except for weeds such as twin

gress and *Chenopodium* species. Work has shown that fairly good kills of most annuals and grasses can be obtained by preparations based on chlorates at rates up to 1000lb. per acre, whereas preparations based on boron require to be applied at rates exceeding 1000lb. per acre.

In the past preparations based on sodium chlorate were used much more widely than today for kikuyu, ragwort, sweet brier, St. John's wort, and variegated thistle. In all cases more suitable chemicals are now available.

List of weeds effectively killed by rates of "Atlacide" and "Polyborchlorate" up to 1000lb. or by Borascu at rates over 1000lb. For details see individual weeds.

Blackberry	<i>Rubus</i> spp.
Black medick	<i>Medicago lupulina</i>
Bracken fern	<i>Pteridium esculentum</i> (Preparations based on boron only)
Browntop	<i>Agrostis tenuis</i>
Burr clover	<i>Medicago arabica</i> and <i>M. hispida</i>
Chewings fescue	<i>Festuca rubra</i> var. fallax
Cocksfoot	<i>Dactylis glomerata</i>
Convolvulus	<i>Convolvulus arvensis</i> (Repeat applications sometimes required)
Crab grass	<i>Digitaria sanguinalis</i>
Gorse	<i>Ulex europaeus</i>
Kikuyu	<i>Pennisetum clandestinum</i>
Oxalis	<i>Oxalis</i> spp.
Prairie grass	<i>Bromus catharticus</i>
Purua grass	<i>Scirpus maritimus</i>
Ratstail	<i>Sporobolus capensis</i>
Reed sweet grass	<i>Glyceria maxima</i>
Rough-stalked meadow grass	<i>Poa trivialis</i>
Ryegrass	<i>Lolium</i> spp.
Sweet vernal	<i>Anthoxanthum odoratum</i>
Timothy	<i>Phleum pratense</i>
Toad rush	<i>Juncus bufonius</i>
Yorkshire fog	<i>Holcus lanatus</i>

Ammate

In the past ammate was used for the control of ragwort. Chemically it is ammonium sulphamate. It has the major disadvantage of being non-selective. For ragwort control it had to be used at rates sufficiently high that associated pasture species were killed. It was also slightly corrosive and could cause skin irritation on prolonged contact. It is non-inflammable and non-hazardous to livestock and in this respect much safer than sodium chlorate or arsenical preparations.

Cyanates

Trial work with cyanates, which are the salts of cyanates such as potassium and sodium cyanates, has shown that they do not compare favourably with new compounds. They have been used for weed control in onions and lawns as a post-emergence treatment at rates of 10lb. to 30lb. Usually weed control has been poor and only seedlings were killed. They may be regarded as contact chemicals.

Calcium Cyanamide

Calcium cyanamide is a fertiliser with weedkilling properties and has been used for weed control in asparagus and onions. There are more suitable chemicals available for weed control in these crops. It kills by direct contact. It is applied as a powder, as it is largely insoluble in water. For optimum weed control the material should be applied under warm, moist conditions (when the foliage of the weeds is wet) and rain should not fall for several days. It will only control germinating weeds up to about $\frac{1}{2}$ in. high. Rates of application are high, 60 to 70lb. being required as a pre-emergence treatment on onions. Heavier rates are usually employed for asparagus weed control.

Sulphuric Acid

Sulphuric acid is a contact herbicide used mainly for the control of weeds in onions. It has many disadvantages. It is very corrosive to equipment and the employer must wear protective clothing; equipment lined with copper has to be employed; it does not give control of grasses, clovers, or weeds developed from suckers, or weeds with a waxy cuticle such as portulaca and to a less degree fat-hen; it must be applied when the onion crop is dry and rain should not fall immediately after the application. Care must be exercised in mixing the material; the acid should always be added to the water and never the reverse. A large quantity of water requires to be applied per acre. If the spray is at all atomised, better weed control occurs, but damage is also done to the onions. Normally a 10 per cent. solution is employed and is applied either as a pre-emergence application or after

the onions have one true leaf, that is 3in. to 4in. high.

Power Kerosene

A lot of trial work conducted in the past showed that power kerosene was useful for the control of weeds in carrots. Each batch of kerosene had to be tested prior to being used, because the percentage of aromatic constituents varies from batch to batch and only some lines are suitable for use.

A much safer material, Shell Weed-killer W, is available. This material should preferably receive prior testing before being applied to the carrot crop. It can be used for pre-emergence weed control at rates of 60 to 80 gallons applied at least 3 days before crop emergence on such crops as beet, lettuces, onions, and carrots. For post-emergence applications it is normally applied to carrots at rates up to 50 gallons per acre after the carrots have one to four true leaves. The application should preferably be made in cool, dry weather. Weed control is satisfactory under these conditions—most germinating weeds are killed, such as fat-hen, red shank, red root, black nightshade, grasses, etc. Weeds developing from suckers are checked temporarily, but soon recover. The final application should be made no later than 40 days before harvest.

Chlorinated Hydrocarbons and Aromatic Solvents

Chlorinated hydrocarbons and aromatic solvents have been tested for the control of floating weeds such as *Lemna minor* and *L. oligorrhiza*. Control of such weeds in still or slowly moving water has been very satisfactory. The disadvantages of the materials are that they are highly toxic

to fish life and could only be used in areas where fish life does not occur. Chlorinated hydrocarbons are applied so that a concentration of about 300 p.p.m. is maintained for up to 60 minutes. Aromatic solvents are employed at up to 500 p.p.m. for up to 30 minutes. Booster shots are usually applied at half the concentration at about $\frac{1}{2}$ mile intervals. These preparations emulsify readily in water, but greater dispersion is obtained by pointing the nozzles upstream under the water.

Plants arising from roots such as raupo and floating sweet grass are not greatly affected by these materials unless cut below the surface and frequent applications are made. The best weed control is obtained under warm water conditions.

A.T.A.

A.T.A. is 3-amino 1,2,4, triazole. It is being tested as an activator for preparations of 2,4-D and 2,4,5-T for the control of gorse, blackberry, and sweet brier. Results of trials conducted to date are not conclusive on these species, but a disadvantage of this material is that in conjunction with 2,4-D or 2,4,5-T it is particularly severe on grasses and clovers. The effect on clovers is greater than the effect from straight 2,4,5-T. This would tend to limit the use of the material. With some forms of 2,4-D and 2,4,5-T it forms insoluble salts, hence it is more safely employed with 2,4-DP and 2,4,5-TP acids.

Methods of Use

In trial work to date A.T.A. and 2,4,5-T have been mixed in the ratio of 1:1, that is 1lb. of A.T.A. to 1lb. of 2,4,5-T. Much more work is required with this compound.

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- ELLIOTTS M.C.P.-40: Buttercup, Dandelion, Fat-hen, Plantain, Red Root, Bathurst Burr, Seedling Docks and all Thistles.
- ELLIOTTS T.C.A.: Twitch or Couch Grass, Tall Fescue (seedlings only), Kikuyu, Paspalum, Yorkshire Fog, Nassella Tussock.
- ELLIOTTS SODIUM CHLORATE: All weeds, but Ragwort in particular.

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SECTION 2 — LIST OF WEEDS AND THEIR CONTROL

All grass weeds are treated under the heading "Grasses". Some sedges are also included under this heading.

In the case of hormone weedkillers all recommendations are given in pounds acid equivalent per acre. Where the term ester is employed it refers to the oil-soluble esters. Where the use of the water-soluble polyethylene glycol ester is recommended it is specifically referred to as such. In all cases the most selective preparation that will control the weed is recommended. In many cases, particularly for the control of annual weeds, esters of 2,4-D would give equal or better control, but as they are less selective, more damage to associated clovers and crops would result from their use.

Alligator Weed

(*Telanthera philoxeroides*)

Alligator weed (*Telanthera philoxeroides*) is localised on the wetland margins of the Northern Wairoa River. For its control 2,4-D is more toxic than M.C.P. At the seedling stage it is killed by 1.0lb. salts and amines of 2,4-D. It shows sufficient susceptibility to M.C.P. salts and amines to be controlled in maize crops at 1.0lb.

Apple of Peru

(*Nicandra physaloides*)

Apple of Peru (*Nicandra physaloides*) is localised in cultivated areas in the northern half of the North Island. A susceptible annual; it is killed at seedling stage by 0.5lb. salts and amines of M.C.P. and 2,4-D. Older plants require up to 1.0lb. for control. It is effectively controlled by pre-emergence applications of M.C.P. and 2,4-D at 2lb.; phenols at 2lb. to 3lb. and C.M.U. at 2½lb. to 5lb. per acre in crops. Salts of phenols in the seed-leaf stage at rates of 1lb. to 2lb. check it effectively.

Apple of Sodom

(*Solanum sodomaeum*)

Apple of Sodom (*Solanum sodomaeum*) is a susceptible semi-woody shrub confined to the northern half of the North Island. Seedling plants are killed by 1.0lb. esters of 2,4-D and older plants by 2.0lb. It is also killed by 2,4,5-T at 2.0lb., but repeat treatments are often necessary. Successful control has been obtained by basal application of esters of 2,4-D and diesel

oil at a ratio of 1.0lb. : 20 gals. of diesel fuel oil.

Australian Fireweed

(*Erechtites atkinsoniae*)

Australian fireweed (*Erechtites atkinsoniae*) is a short-lived perennial largely confined to the north of the North Island. This plant establishes on low-fertility areas and open places such as bush burns, but readily goes out with stocking and improved pastures. It is susceptible to esters of 2,4-D at 1lb. to 2lb. as seedlings, but control should be by the improvement of pastures, where this weed occurs in newly broken in areas. In waste areas it has been killed by C.M.U. at rates over 30lb.

Australian Flax

(*Linum marginale*)

Australian flax (*Linum marginale*) is frequent in poor pasture and in waste places throughout New Zealand. Plants are susceptible as seedlings to salts and amines of M.C.P. and 2,4-D up to 1.0lb. Older plants are killed by esters of 2,4-D at 1lb. to 2lb. Both this species and purging flax (*L. catharticum*) grow in poor pastures, and control should be by improving the pasture, as these species do not survive under heavy stocking.

Barberry

(*Berberis vulgaris*)

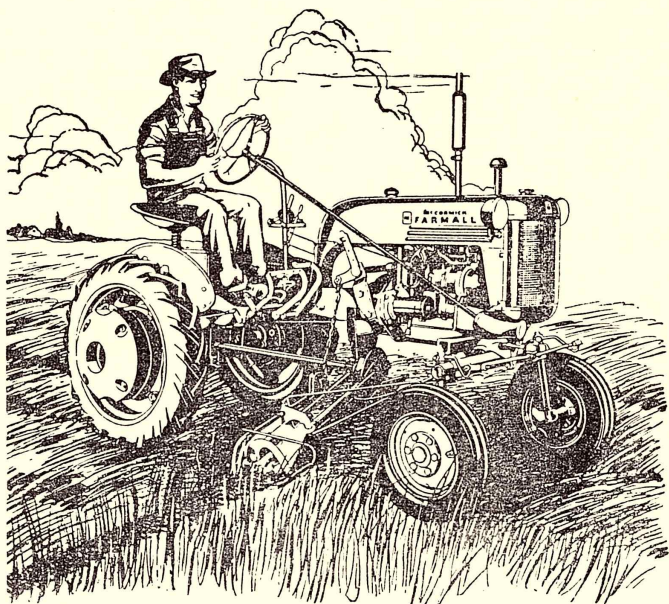
Barberry (*Berberis vulgaris*) is a woody shrub occurring more frequently in both Islands. Shows high resistance to 2,4,5-T and 2,4-D as an over-all spray, but is slightly susceptible to high rates of esters of M.C.P. at 4lb. to 8lb. or spot treatments of 8000 p.p.m. More work is required on new types of preparations. Basal applications of M.C.P., 2,4-D, and 2,4,5-T at 8000 to 12,000 p.p.m. in diesel fuel oil have given good results. Promising results have been obtained by 5 gms. to 10 gms. of C.M.U. applied to the base of the tree.

Bathurst Burr

(*Xanthium spinosum*)

Bathurst burr (*Xanthium spinosum*) is an annual occurring most frequently in waste places in the North

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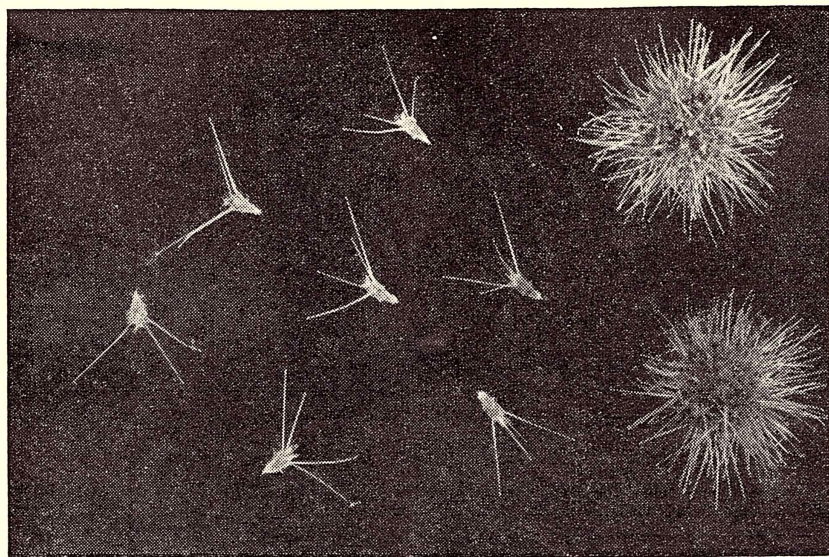
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Close-up of seed head of bidi-bidi, and individual barbed bristles.

Island, but occasionally in open pastures and crops. Salts and amines of M.C.P. and 2,4-D at 0.5lb. control seedlings in tolerant crops and pastures. For older plants 1.0lb. is used. Effective control is gained with esters at 1.0lb. at all stages of growth if Bathurst burr is growing in association with other plants in waste places.

Beaked Parsley

(*Anthriscus vulgaris*)

Beaked parsley (*Anthriscus vulgaris*) is a perennial plant infrequent in waste places in the southern half of the North Island and eastern Southland. It is susceptible as seedlings to 1.0lb. esters of 2,4-D and shows slight susceptibility up to flower-head formation to esters of 2,4-D at 2lb. to 3lb.

Bidi-bidi or Piripiri

(*Acaena* spp.)

Bidi-bidi or piripiri (*Acaena* spp.) is a perennial weed abundant in waste places and poor pastures throughout New Zealand. It requires 3lb. to 4lb. of 2,4,5-T applied in the flowering or seed stage. Repeat treatments are necessary. As 2,4,5-T is very toxic to clovers in pastures, the treatment should be made

as spot applications. Spray application should not be used widely for the control of this species in pastures, as better results are obtained by pasture improvement methods. Species of *Acaena* do not compete with good pastures.

Blackberry

(*Rubus* spp.)

Preparations of 2,4,5-T have proved the most effective chemical means of controlling blackberry. Further work is required with more recently developed chemicals. Occasionally blackberry is killed with one application of 2,4,5-T; more usually regrowths occur and 2 to 3 applications are required for complete kills. In stocked areas one application is usually sufficient if the area is oversown, fertilised, and stocked. The few regrowths present after the first application can be destroyed by pasture improvement methods.

Factors Affecting Control

The following matters have to be considered in the control of blackberry with chemicals:—

Time of application: The time of application of the chemical is very



Blackberry satisfactorily controlled with esters of 2,4,5-T applied at flowering stage.

important. The best periods are summer and early autumn. Plants should be in full leaf and second-year canes should be fruiting or past fruiting. Spring application results in a poor foliage and cane check, with strong regrowths later appearing from the base of the crown or from laterally growing roots. The late autumn and winter applications require excessive rates to secure a foliage and cane check. Because there is little food movement once the plants are defoliated by frosts, only a contact kill is possible and there is much subsequent regrowth.

Rates of application: In summer and early autumn 3lb. to 4lb. of acid equivalent per acre is sufficient for control. To secure a slow kill of foliage and canes the rate should be varied for different districts. Normally, the slower the foliage and cane check to ground level the fewer the regrowths. A quick check resulting from an application in December or January of excessive amounts of oil-soluble esters usually results in strong regrowths in early autumn. A slow cane check takes up to several months to reach ground level. Lower rates of application will be necessary for northern areas and higher rates for most southern districts.

Cover or spray distribution: Trials have shown that sufficient spray can be taken in by the leaves of blackberry for control to be obtained, as is

shown by the results obtained with the amine salts of 2,4,5-T, which are repelled by the waxy surface of the canes. The cylindrical shape of canes makes them difficult to wet; consequently a fine spray should be used so that the spray particles have a better chance of adhering to canes if they are driven past the foliage.

For small first-year canes 60 gallons of water per acre is sufficient with low volume nozzles to obtain an adequate cover. For "old-man" blackberry up to 100 gallons of water per acre is necessary to secure a complete foliage cover. Where first-year canes arise from cutting or rolling operations boom spraying may be feasible.

Carrier or spreader for 2,4,5-T: Water is the best carrier for 2,4,5-T. Kerosene, diesel fuel oil, or other aromatic oils hasten the foliage check, and this results in more regrowths. In the stump method 2,4,5-T ester can be used with these oils, though they have not proved very satisfactory in a 1:10 solution painted on the stump immediately after the plant has been cut down. Another alternative, not yet proved by trial work, is to apply a strong solution of 2,4,5-T and oil in the dormant season to the canes of blackberry. The rate should be 3lb. to 4lb. of acid equivalent in 5 gallons of oil per acre. This method would be more expensive than that in which water is used in summer or early autumn.

Formulations: No difference has been detected between volatile and non-volatile preparations of 2,4,5-T. Foliage cover is not nearly so important for blackberry as for some other scrub species such as gorse, manuka, or tauhinu.

Mixtures of 2,4-D and 2,4,5-T are not recommended for the control of blackberry. They depend chiefly on the 2,4,5-T content for their action and therefore are not economical in the control of this weed.

Treatment of regrowths: Regrowths should be allowed to grow for one year, and should then be treated in summer and early autumn after the leaves are fully grown. In waste areas regrowths have been killed by C.M.U. at rates over 80lb. Borascu and "Polyborchlorate" at rates of 2000lb. and 1000lb. have been satisfactory.

Black Medick

(*Medicago lupulina*)

Black medick (*Medicago lupulina*) is an annual common in waste places and dry pastures in both Islands. It is killed as seedling by esters of 2,4-D at rates over 1lb. In waste areas it is killed by "Atlacide" and "Polyborchlorate" at rates over 500lb. and Borascu at rates over 1000lb. C.M.U. is very effective at rates over 30lb.

Black Nightshade

(*Solanum nigrum*)

Black nightshade (*Solanum nigrum*) is an annual or biennial plant occurring in waste places and cultivated land. It is killed as seedlings with 0.5lb. salts and amines of M.C.P. and 2,4-D. Semi-mature plants are killed with esters of 2,4-D at 1.0lb. to 1.5lb. It is effectively killed by pre-emergence applications of M.C.P., 2,4-D at 1lb. to 2lb., phenols at 2lb. to 3lb., and urea compounds at 2½lb. to 5lb. It is killed by salts of phenols up to 2in. high at 1lb. to 2lb., Oktone at 4lb. plus diesel fuel oil, and aromatic oils at 50 to 75 gallons. Also it is killed at pre-emergence by C.I.P.C. at rates over 3lb.

Bladder Campion

(*Silene cucubalus*)

Bladder campion (*Silene cucubalus*) is a perennial plant growing in poor

pastures, waste places, and crops in both Islands. It is more susceptible to M.C.P. than 2,4-D. Seedling plants are checked by 1.0lb. of the salts and amines of M.C.P. and 2,4-D. They require repeat applications of ester of 2,4-D at 2.0lb. to 3.0lb. for destruction of mature plants. This plant is possibly quite susceptible to esters of 4-C. It shows too much resistance to M.C.P. and 2,4-D to be killed in crops. It is controlled by pre-emergence applications of M.C.P. and 2,4-D at 2lb. to 4lb., phenols at 2lb. to 4lb., and urea compounds at 2½lb. to 5lb. if the plants arise from seedlings. Control by post-emergence applications of salts of phenols and aromatic oils is not effective unless treated in the seed leaf stage.

Bracken Fern

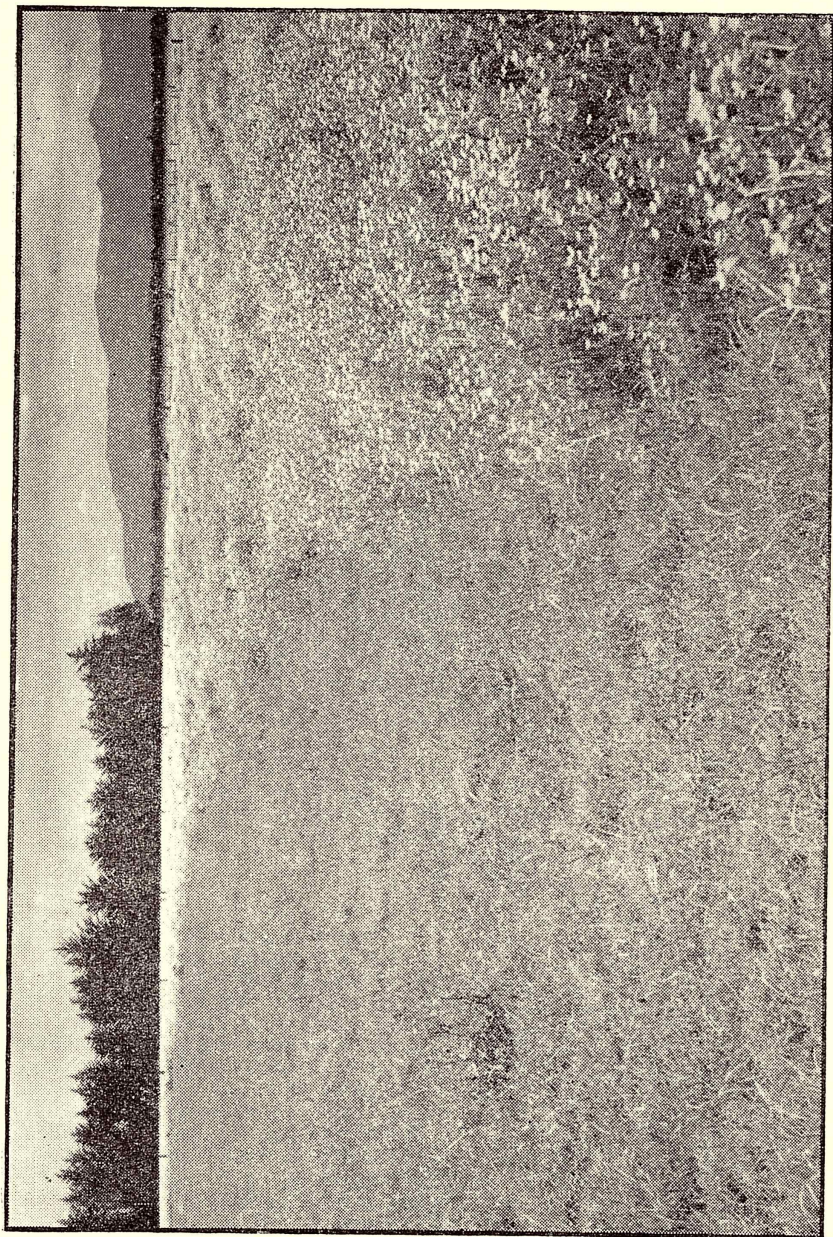
(*Pteridium esculentum*)

Bracken fern (*Pteridium esculentum*) shows high degree of resistance to M.C.P., 2,4-D, and 2,4,5-T, but initial trials with 4-C are very promising. Fern should be sprayed in the young frond stage with 4 to 6lb. of 4-C in waste places, and 2 to 3lb. in areas of pasture establishment. The area to be controlled should be burnt, oversown, and fertilised and the young regrowth sprayed. Repeat sprayings are probably necessary for eradication. In waste areas borax and Borascu at rates over 2000lb. and C.M.U. at rates over 80lb. have eliminated fern. Rates lower than the above have given temporary control.

Broom

(*Cytisus* spp.)

Broom (*Cytisus monspessulanus*) and Scotch broom (*Cytisus scoparius*) react the same way to hormone weed-killers. In the dicotyledon seed leaf stage plants are resistant. When 4in. to 6in. high they are quite susceptible to esters of 2,4-D at 1.0lb. Plants show susceptibility to 2,4-D esters at 2lb. to 3lb. until semi-mature. Once the plants are mature better control is obtained with esters of 2,4,5-T at 2lb. to 3lb. Plants should only be sprayed in full leaf. Poor results are obtained if plants are sprayed when leaves are developing or the plants are in full flower. The best results have been obtained when the plants are in seed



Annual buttercups are very easily controlled by salts and amines of M.C.P. and 2,4-D. The application should be made when the buttercups are in the seedling stage of growth.



A close-up of the control of creeping crowfoot. Established plants of this species are best treated at this stage, which is that approaching flower-head formation.

head, late summer or early autumn. In the leafless stage satisfactory control has been obtained by using diesel fuel oil as a carrier instead of water.

Burdock

(*Arctium lappa*)

Burdock (*Arctium lappa*) is a susceptible biennial occurring locally in waste places. It is susceptible up to flower-head formation. Seedlings require 0.5lb. and older plants 1.0lb. of the salts and amines of M.C.P. and 2,4-D. It is killed by esters of 2,4-D if it is growing in association with other plants.

Burr Clovers

(*Medicago* spp.)

Burr clovers (*Medicago arabica* and *M. hispida*), annual species occurring in crops on peaty land, are effectively destroyed when 2in. to 4in. high by salts of phenols at 1lb. to 2lb. and aromatic oils. Control of this species is not satisfactory by pre-emergence methods. In seed crops this species is killed in the seedling stage with esters

of 2,4-D at rates over 1lb. In waste areas it is killed by "Atlacide" and "Polyborchlorate" at rates over 500lb., and Borascu at rates over 1000lb. C.M.U. is highly effective at rates over 30lb.

Buttercups

(*Ranunculus* spp.)

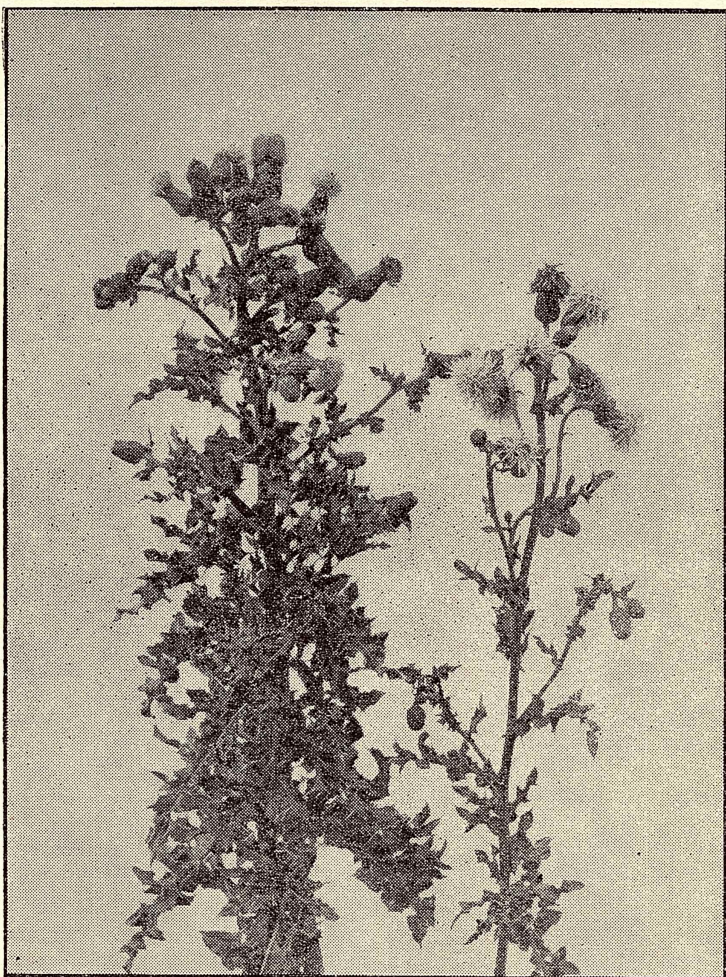
The annual species *R. sceleratus* (celery-leaved buttercup), *R. parviflorus* (small-flowered crowfoot), and *R. sardous* (hairy crowfoot) are highly susceptible to salts and amines of M.C.P. and 2,4-D. The plants are best treated prior to flower-head formation at up to 1.0lb. The perennial species *R. repens* (creeping crowfoot) and in particular *R. acer* (field buttercup and giant buttercup) should only be treated with the salts and amines of M.C.P. The results are poor with 2,4-D. Field buttercup should be treated at up to 2.0lb. of M.C.P. just after the plant has reached maximum leaf development; that is flower stalk initiation. Usually a second application is required a year later for complete suppression for several years.

Buttercups in dairy pastures are probably increasing with improving fertility, and spraying every 2 or 3 years is probably necessary to keep them suppressed. The poisonous species *R. rivularis* is susceptible to M.C.P. Sprayed areas should not be stocked for 3 or 4 days after spraying. In waste areas C.M.U. at rates over 40lb. has given control. Control at lower rates may be possible with P.M.U.

Californian Thistle

(*Cirsium arvense*)

Californian thistle (*Cirsium arvense*) is more susceptible to salts and amines of M.C.P. than it is to the corresponding 2,4-D preparations. Established areas in old pastures require up to 3 annual repeat treatments for destruction. The plants should be sprayed after the maximum leaf stage; that is,



Male plant (right) of Californian thistle and female plant (left). Established plants are best controlled in conjunction with cultivation by the salts and amines of M.C.P. and 2,4-D.

at flower stalk initiation at 1.0lb. of M.C.P. If the application is delayed until early seed-head stage, the best results are obtained with the esters of 2,4-D (esters of M.C.P. are preferable but not available). Alternatively the thistle should be mown and treated in the autumn at the rosette stage with the salts and amines of M.C.P. at 1.0lb.

Californian thistle in old pastures is probably best controlled by ploughing and discing and sowing a resistant crop such as cereals or potatoes. The thistle in the crops can be treated with up to 1.0lb. of M.C.P. Discing breaks up the underground rhizomes so that each plant arises from a small length of growing rhizome. Dormant roots are not affected by hormones and discing encourages root growth. After the crop the area can then be sown to a pasture and the thistle treated in the pasture when once established. If the pasture is autumn sown, the thistles should be sprayed the following spring and if spring sown, the application should be made the following autumn. In waste areas it

has been killed by C.M.U. at rates over 40lb.

Cape Tulip

(*Homeria collina*)

Cape tulip (*Homeria collina*), a very poisonous bulbous plant, is confined possibly to Portland Island, Hamilton Bay (near French Pass), and Woolley's Bay (near Whangarei). It is susceptible to esters of 2,4-D at 2lb. to 3lb. in young leaf stage, when leaves are 6in. to 9in. high. Dormant bulbs are not affected by spray application. The Department of Agriculture is anxious to see this weed eliminated, as it is poisonous to both man and animals and spreads rapidly by seeds and bulbs. The seeds are wind blown.

Cape Weed

(*Cryptostemma calendulacea*)

Cape weed (*Cryptostemma calendulacea*) is a biennial to perennial plant found often in waste places and seldom in poor pastures. Shows greater susceptibility to M.C.P. than 2,4-D. It can be controlled by esters of M.C.P. up to early flowering stage, but these preparations are not commercially available. Salts and amines of M.C.P. are satisfactory at 1lb. to 2lb. at the seedling stage and up to early flower stalk initiation, if growing conditions are good. Esters of 2,4-D at 1lb. to 2lb. secure satisfactory control, particularly at the seedling stage of growth. Wherever possible this weed should be treated in the early stages of growth, as its resistance increases with maturity and satisfactory control cannot be obtained at the later stages of growth until esters of M.C.P. are commercially available. It has been killed in crops at the seed-leaf stage by salts of phenols at 1lb. to 2lb.



Cape tulip is possibly the most potentially dangerous weed in New Zealand. The close-up of the infestation shown is in a good pasture.

Catchfly

(*Silene gallica*)

Catchfly (*Silene gallica*) is an annual occurring in waste places and cultivated land in both Islands. Possibly it is more susceptible to M.C.P. than 2,4-D. Seedlings are checked or killed by 1.0lb. salts and amines of M.C.P. or 2lb. to 3lb. of esters of 2,4-D. It is possibly susceptible to 4-C at 1lb. to

2lb. In crops it can be effectively killed in the seed-leaf stage with salts of phenols at 1lb. to 2lb. or by aromatic oils.

Catsear

(*Hypochaeris radicata*)

Catsear (*Hypochaeris radicata*) is a susceptible perennial abundant in low fertility pastures, playing greens, and waste places throughout New Zealand. Seedlings are killed by 0.5lb. of salts and amines of M.C.P., 2,4-D, and esters of 4-C; older plants by 1.0lb. of salts and amines of M.C.P. and 2,4-D and 2.0lb. of esters of 4-C. It is also killed by esters of M.C.P. and 2,4-D, but not 2,4,5-T. Esters of 2,4,5-T defoliate the plant (contact kill) and regrowths subsequently occur. Catsear is found in low fertility pastures and not in high fertility pastures. Spraying of catsear in low fertility pastures is not recommended, as control is temporary; the cause has not been removed and reinfestation soon takes place. Control should be by pasture improvement methods. It can be killed in crops by salts of phenols at 1lb. to 2lb. in the seed-leaf stage or by pre-emergence applications of phenol and M.C.P. and 2,4-D, but it shows a high resistance to urea compounds and carbamates.

Chamomile

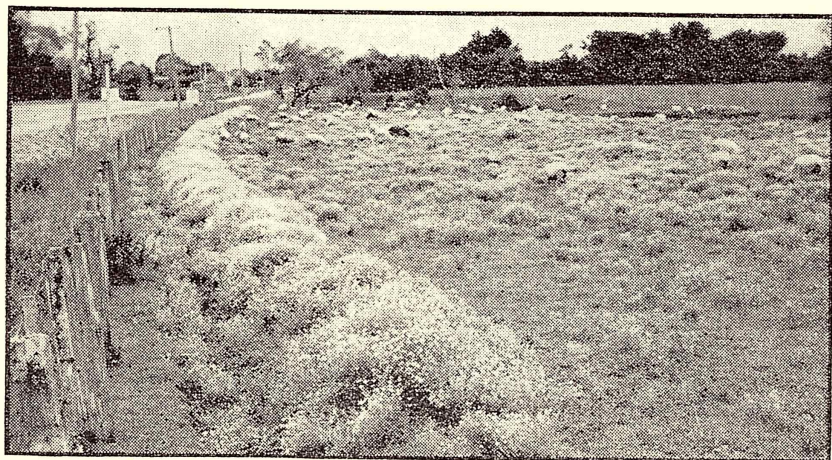
(*Matricaria chamomilla*)

A fairly common annual, chamomile (*Matricaria chamomilla*) grows in waste places and cultivated land in both Islands. In the seedling stage it is controlled by the salts and amines of M.C.P. and 2,4-D at 1.0lb. and up to flower-head formation at 1lb. to 2lb. esters of 2,4-D.

Charlock

(*Sinapis arvensis*)

Charlock (*Sinapis arvensis*) is a susceptible annual occasionally found in cultivated land and waste places in both Islands, but is more common in Otago and Southland. It is killed at all stages up to flower-head formation by salts and amines of M.C.P. at 0.5lb. to 1.0lb. It is susceptible enough to be killed in cereals, potatoes, and linseed crops with salts and amines of M.C.P. at the above rates. It is killed up to 4in. high by salts of D.N.B.P. at 1lb. to 2lb. and also aromatic oils. Effective control is gained by pre-emergence applications of hormones at 1lb. to 2lb., phenols at 2lb. to 3lb., and urea compounds at 1lb. to 2lb. High resistance is shown to pre-emergence treatments of T.C.A. and C.I.P.C.



A dense infestation of chamomile in a run-out pasture. This weed should be controlled by pasture management and not by chemical spraying.

Chickweed

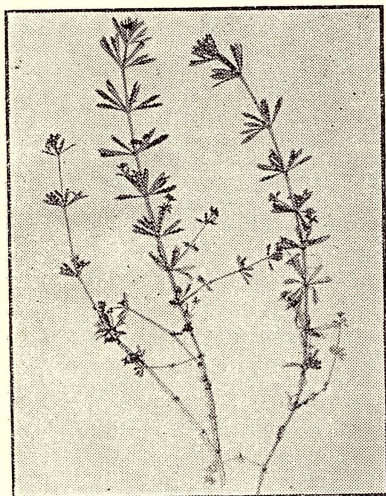
(*Stellaria media*)

Chickweed (*Stellaria media*) is a common annual in waste places and cultivated areas throughout New Zealand, and more recently has occurred in high fertility pastures. Seedlings are checked and killed with salts and amines of M.C.P. and 2,4-D at 1lb. to 2lb. Plants up to flowering stage are checked or killed with 1lb. to 2lb. of esters of 2,4-D, the polyethylene glycol ester showing no advantage over the oil-soluble esters. It is probably slightly more susceptible to M.C.P. than 2,4-D. Preparations of 4-C offer possibilities of control. It is effectively killed by salts of D.N.B.P. at 1lb. to 2lb. when 2in. high. Control is gained by pre-emergence applications of C.I.P.C. at 2lb. to 4lb., by C.M.U. at 2½lb. to 5lb., by T.C.A. at 30lb., and by Oktone at 4lb. plus diesel fuel oil.

Cleavers

(*Galium aparine*)

Cleavers (*Galium aparine*) is a common annual in waste places and hedgerows throughout New Zealand. It is susceptible to esters of 2,4-D at 1lb. to 2lb. only as seedlings. Established plants can be killed by applying



Cleavers is a difficult weed to kill with hormone preparations.

oil-soluble esters of 2,4-D in diesel fuel oil. Water-soluble preparations of M.C.P. and 2,4-D have no effect on established plants. It is killed in crops in the seed-leaf stage by salts of D.N.B.P. at 1lb. to 2lb. In waste areas it is killed by C.M.U. at rates over 30lb.

Convolvulus or Bindweed

(*Convolvulus arvensis*)

Convolvulus or bindweed (*Convolvulus arvensis*) and white bindweed or greater bindweed (*Calystegia sepium*) are often confused and both are commonly called convolvulus. True convolvulus occurs in waste places and cultivated areas throughout New Zealand, and because of its deep rooting system is difficult to eradicate. Greater convolvulus occurs more usually from Canterbury northwards. There is a white and a pink flowered variety. This weed occurs more commonly in waste places such as along railway lines and occasionally creeps out of hedgerows into cultivated land. It is an easy weed to destroy.

Both the above species are susceptible to salts and amines of 2,4-D at 1lb. to 2lb. Greater convolvulus is usually destroyed by a single application. True convolvulus requires repeat applications for destruction. For both species the first application should be made when the weeds are about to flower. Further treatments should be applied to the convolvulus annually until it is destroyed. Regrowths after the first application should be allowed to recur until most of the leaves are fully grown before a repeat application is made. In waste areas C.M.U. at rates of 80lb. and Borascu at rates over 2000lb. have given good control if not eradication. Possibly P.M.U. would be required at lighter rates.

Cornbind or Black Bindweed

(*Polygonum convolvulus*)

Cornbind or black bindweed (*Polygonum convolvulus*) is an annual weed occurring fairly commonly in waste places and cultivated land in both Islands. Even in the seedling stage of growth this weed is only checked by salts and amines of M.C.P. and 2,4-D at 1.0lb. Of the hormone

preparations available the polyethylene glycol ester of 2,4-D has given the best results, at 1lb. to 2lb. from seedling to pre-flowering stage. Barley and wheat show sufficient tolerance to the above preparation once past the six true leaf stage to allow control. Rates of application should not exceed 1.0lb. Oats are too susceptible to be treated with the polyethylene glycol ester. It is killed by salts of phenols at 1lb. to 2lb. at up to 3in. stage. It is effectively controlled by pre-emergence applications of hormones at 1lb. to 2lb., C.I.P.C. at 2lb. to 4lb., urea compounds at 2½lb. to 5lb., and phenols at 2lb. to 4lb. T.C.A. is also effective at 20lb. and promising results have been obtained with M.H. compounds at 1lb. to 2lb. in legumes when the weed is establishing. It is killed by aromatic oils as seedlings.

Cotton Thistle

(*Onopordon acanthium*)

Cotton thistle (*Onopordon acanthium*) is an annual of very localised occurrence. It is susceptible up to flowering stage to esters of 2,4-D; seedlings at 1lb. and older plants at 2.0lb.



Cotton thistle or true Scotch thistle. This plant can be killed by hormone preparations in the early growth stages.

Creeping Mallow

(*Modiola caroliniana*)

Commonly occurring in waste places and playing greens from North Canterbury northwards, creeping mallow (*Modiola caroliniana*) is an annual to biennial plant susceptible to all preparations of M.C.P. and 2,4-D at 1.0lb. Applications should be made at the flowering stage. In playing greens it is checked by 2,4,5-T, but regrowths occur.

Cudweed

(*Gnaphalium luteo-album*)

Cudweed (*Gnaphalium luteo-album*) is a common annual throughout New Zealand in waste places. It is controlled by esters of 2,4-D at 1lb. in seedling stage and esters of 2,4-D at 1lb. to 2lb. up to early flowering stage.

Curnow's Curse

(*Calandrinia caulescens*)

Curnow's curse (*Calandrinia caulescens*) is an annual occurring commonly in cultivated areas in the north of the South Island. It is susceptible as seedlings to esters of 2,4-D at 1lb. Older plants are checked. This species shows too much tolerance except as seedlings to be killed without clover or crop damage.

Cut-leaved Geranium

(*Geranium dissectum*)

Cut-leaved geranium (*Geranium dissectum*) is an annual common in waste places in both Islands. It is killed by salts and amines of M.C.P. and 2,4-D; as seedlings at 0.5lb. and older plants at 1.0lb. It is susceptible to flower-head formation.

Daisy

(*Bellis perennis*)

Daisy (*Bellis perennis*) is common in closely grazed damp pastures and waste places throughout New Zealand. A perennial plant, but shows greater susceptibility to M.C.P. than 2,4-D. Best control is obtained with the salts and amines of M.C.P. at 1.0lb. The application should be made as the flower stalk is emerging from the

rosette. In most pastures this weed is kept out by pasture management methods, but in some Southland pastures this weed is difficult to eradicate by pasture management and an annual or bi-annual application is required to keep pastures from being infested.

In playing areas esters of 2,4-D give satisfactory suppression with some kills at 1lb. to 2lb. Esters of 2,4,5-T cause defoliation with subsequent regrowths at rates over 1.0lb. Regrowths should be treated at full leaf development.

Dandelion

(*Taraxacum officinale*)

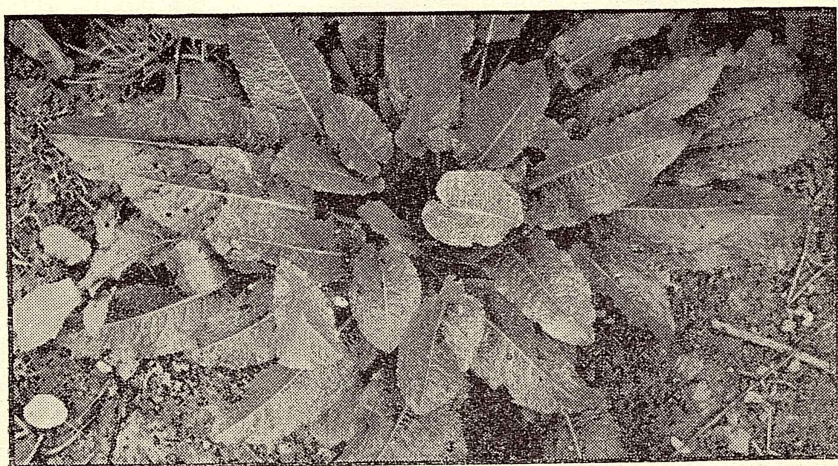
A perennial rosette herb, dandelion (*Taraxacum officinale*) occurs in waste places and in damp pastures throughout New Zealand. A susceptible plant, it is killed by all preparations of M.C.P. and 2,4-D; seedlings at 0.5lb. and mature plants up to flowering stage at 1.0lb. In playing greens esters of 2,4,5-T defoliate mature plants with subsequent regrowths. Spray applications should not be employed to control this weed in pastures; control should be by pasture improvement methods. Established dandelions in waste areas require rates of 40lb. and over of C.M.U. for control. Germinating seedlings persist at rates up to 20lb. per acre.

Docks

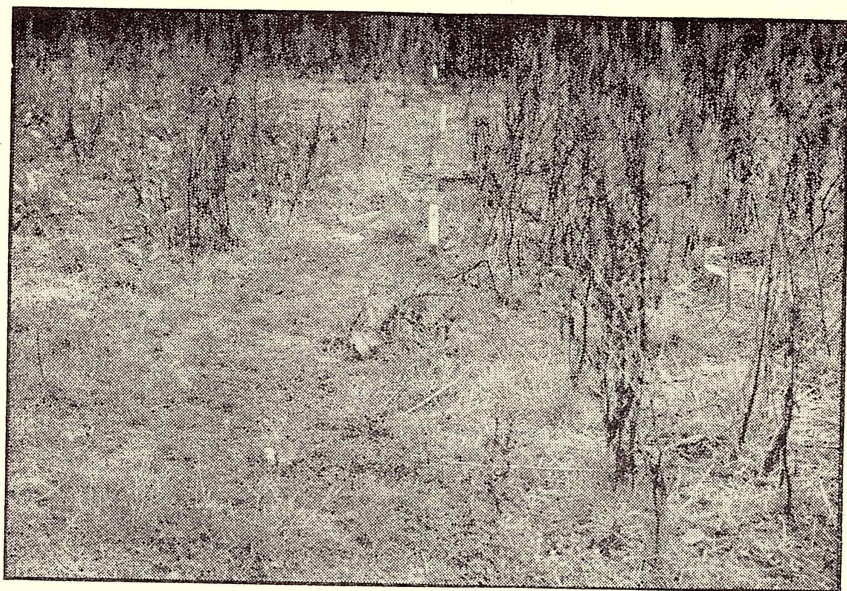
(*Rumex* spp.)

Broad-leaved dock (*Rumex obtusifolius*), curled dock (*R. crispus*), and fiddle-leaved dock (*R. pulcher*) are three species which are all perennials and occur in waste places and pastures throughout New Zealand. Of the preparations available to date the polyethylene glycol ester of 2,4-D has given the best control of established docks at 2.0lb. applied when the docks are in the late flowering stage. The amine salt of 2,4-D at the same rate is slightly less effective. Seedling plants up to the 4 to 5 leaf stage can be killed with salts and amines of M.C.P. at 1lb. Regrowth docks after spraying or cultivation should be treated at the full leaf stage, that is, full rosette stage. Curled dock is the most susceptible species, broad-leaved dock is intermediate, and fiddle-leaved dock is the most resistant species.

In pastures clover damage is associated with the use of hormones for dock control, particularly the polyethylene glycol ester of 2,4-D. Clover damage may be reduced by prior hard grazing, but reduction of clover in late November-early December (period when docks in late flowering stage) is not as serious as in early spring. Docks on dairy farms are probably increasing as the fertility is built up and with



Established docks are difficult to kill with hormone preparations and must be treated at the late flowering stage.



Docks successfully treated in left foreground at the flower-bud stage with amine 2,4-D and polyethylene glycol ester of 2,4-D. The plot at right shows good recovery from a treatment of the butyl ester of M.C.P.

rotational grazing an annual or biennial application is necessary to keep these types of pastures weed free.

In leguminous crops excellent control of docks has been obtained with M.H. compounds applied at 1lb. to 4lb. when the docks have been at the seedling stage of growth or on succulent regrowths. Poor control has been obtained on established woody plants. In crops in the seed leaf stage it is checked by salts of D.N.B.P. at 2lb. Germinating seeds are effectively killed by pre-emergence applications of hormones at 2lb. to 4lb. and C.I.P.C. at 2lb. to 4lb. and by urea compounds at 2½lb. to 5lb. In waste areas rates of 40lb. of C.M.U. have been required for control.

Dove's Foot

(*Geranium molle*)

Dove's foot (*Geranium molle*) is an annual common throughout New Zealand. It is killed by salts and amines of M.C.P. at 0.5lb. as seedlings. It is susceptible up to flower-head formation at rates up to 1.0lb.

Fat-hen

(*Chenopodium* spp.)

The first species of fat-hen (*Chenopodium album*) is very common in cultivated land and waste places throughout New Zealand. The second species (*C. pumilio*) occurs in the same localities. Both species are annuals. As seedlings they are susceptible to salts and amines of M.C.P. and 2,4-D at rates up to 1.0lb. Resistance to the water-soluble preparations increases rapidly as the plant matures and once past 6in. to 12in. stage of growth shows too much resistance to be killed or severely checked in hormone tolerant crops such as potatoes, maize, and cereals. For good control the plants should be sprayed before they are 6in. high. Fat-hen is killed by salts of phenols up to 2in. at rates of 1lb. to 2lb. and by aromatic oils. It is effectively killed by pre-emergence applications of hormones at 1lb. to 2lb., C.I.P.C. at rates over 4lb., phenols at 2lb. to 4lb., and urea compounds at 2lb. to 4lb. Also it is killed by Oktone

at 4lb. plus diesel fuel oil and T.C.A. at rates of 10lb. to 20lb.

Fennel

(*Foeniculum vulgare*)

Fennel (*Foeniculum vulgare*) is common to locally abundant throughout New Zealand and is a semi-tolerant perennial susceptible to esters of 2,4-D as seedlings at rates of 1.0lb. Older plants up to full rosette require a rate of 2lb. to 3lb. Once the plants have reached early flower-head formation they are more susceptible to esters of 2,4,5-T at rates of 1lb. to 2lb. A repeat application is probably necessary for complete kills. In waste areas rates over 40lb. of C.M.U. have been required for control.

Field Chickweed

(*Cerastium arvense*)

A perennial localised in pastures and cultivated areas in Canterbury, field chickweed (*Cerastium arvense*) is controlled by esters of 2,4-D at rates of 1lb. to 2lb. as seedlings. Once fully established it is very difficult to kill. Repeat applications of esters of 2,4-D are required. Further work is necessary, particularly with 4-C. It is killed

by salts of phenols when up to 2in. high at rates of 1lb. to 2lb. and by aromatic oils. It is effectively killed by pre-emergence applications of hormones at 1lb. to 2lb., C.I.P.C. at 2lb. to 4lb., phenols at 2lb. to 4lb., and urea compounds at 2lb. to 4lb. T.C.A. also shows effects at 20lb. to 30lb.

Field Horsetail

(*Equisetum arvense*)

Confined to one area at Wanganui, field horsetail (*Equisetum arvense*) is a rhizomatous perennial sending up annual shoots. The annual shoots are checked by esters of M.C.P., 2,4-D, and 2,4,5-T when young at 2lb. to 4lb. Further work is required with 4-C.

Fleabane

(*Erigeron* spp.)

Canadian fleabane (*Erigeron canadensis*) is an annual to biennial plant fairly common in waste places throughout New Zealand. Fleabane (*E. crispus*) is an annual occurring less commonly and is largely confined to the North Island. Both species as seedlings are killed with esters of 2,4-D at 1lb. to 2lb. In the late flowering and early seed-head stage best



Established fat-hen in a lucerne crop. Fat-hen seeds in the soil can reach populations exceeding 100 million seeds per acre.



A dense infestation of fumitory in a pea crop. The control of this weed is possible with D.N.B.P. in this crop.

control is obtained with esters of 2,4,5-T at 1lb. to 3lb.

Foxglove

(*Digitalis purpurea*)

Foxglove (*Digitalis purpurea*) is a biennial plant occurring in bush burns and waste places in both Islands. It is susceptible up to the pre-flowering stage to esters of 2,4-D at 1lb. to 2lb., but as foxglove does not compete with good pasture, control in these areas should be by pasture management.

Fumitory

(*Fumaria muralis*)

An annual found in cultivated land and waste places throughout New Zealand, fumitory (*Fumaria muralis*) shows sufficient susceptibility in crops to be checked in early growth stages by salts and amines of M.C.P. and 2,4-D at rates up to 1lb. Mature plants show too much resistance to be checked in hormone tolerant crops. Fumitory is effectively killed up to 3in. high by salts of phenols at 1lb. to 2lb.

Goat's Rue

(*Galega officinalis*)

A semi-woody perennial confined to the vicinity of the Manawatu River,

goat's rue (*Galega officinalis*) is resistant in the dicotyledon leaf stage, then shows susceptibility to esters of 2,4-D at 2lb. to 3lb. up to semi-woody stage of growth. Once in the semi-woody stage best control is obtained with esters of 2,4,5-T at 2lb. to 3lb. Mixed growth stages are suitably controlled with mixed 2,4-D and 2,4,5-T preparations. Regrowths from spraying or cutting should be treated at the full rosette stage.

Gorse

(*Ulex europaeus*)

For the control of gorse (*Ulex europaeus*) with 2,4,5-T preparations treatment in the different stages is as follows:—

Seedling gorse past the true seed-leaf stage is killed very readily with the oil-soluble 2,4,5-T preparations at rates of 1lb. to 2lb. of acid equivalent per acre.

Regrowth gorse from 1ft. to 3ft. high: Though gorse of this nature is just as susceptible as seedling gorse to oil-soluble esters of 2,4,5-T, greater care is required to obtain good kills. The rates of application are the same as for seedling gorse, but if the application is made too soon after burning or cutting, poor results occur. The gorse

should be at least 12in. high and a complete foliage or stem cover is essential.

Gorse with green stems 3ft. to 5ft. high: At this stage gorse is fairly easily controlled with hormones of 2,4,5-T base. Though it is susceptible to oil-soluble esters of 2,4,5-T at 3lb. to 4lb. of acid equivalent per acre, factors such as the necessity of securing a complete foliage and stem cover and of obtaining access through compacted clumps make control very difficult. Isolated bushes or small clumps that can be covered properly are easily killed.

"Old-man" gorse with brown bark on stem: This gorse is susceptible to oil-soluble esters of 2,4,5-T at rates of over 4lb. of acid equivalent per acre, but repeat applications are necessary for complete eradication. Complete foliage cover is very difficult to obtain and gorse with mature bark is able to send out new growth from the stem.

Gorse over 3ft. to 5ft. high: This is best burnt or cut, and the regrowths treated as described. Alternatively such gorse should be cut and a solution of an oil-soluble ester and diesel fuel oil or kerosene applied to the freshly cut surfaces of the stumps. The plants should be cut as close to the ground as possible; if this is not done, the bark should be peeled back on stumps over 3in. to 4in. high. One pound of acid equivalent of 2,4,5-T in 10 to 15 gallons of diesel fuel oil forms a suitable solution.

Factors Affecting Control

Factors to be considered for controlling gorse with 2,4,5-T are as follows:—

Time and rates of application: Before flowering, seedling gorse may be destroyed from October to March inclusive with chemical applied at a rate of 2lb. of acid equivalent per acre. In northern districts the rate may be lowered, particularly on a hot day. From the middle of December to February the rate can be lowered to 1lb. of acid equivalent per acre. Regrowth gorse is best treated from the middle of December to late February, when the new season's growth has fully formed and food is being taken into the roots. In these months also the plants are not in heavy flower. This

is important as the flowers tend to absorb spray and then drop off, poor control resulting. The stump treatment may be carried out at any time of the year.

"Old-man" gorse in heavy flower shows great resistance to the oil-soluble esters in late autumn and winter. Poor results can be expected if regrowth gorse is treated in adverse conditions; for example, cold, wet soils and low temperatures.

Cover or spray distribution: A complete foliage and stem cover is essential, particularly for regrowth and older gorse. Unless the whole plant is completely covered, the unsprayed area will throw out shoots. Boom spraying is satisfactory for short gorse, provided a large volume of water is used.

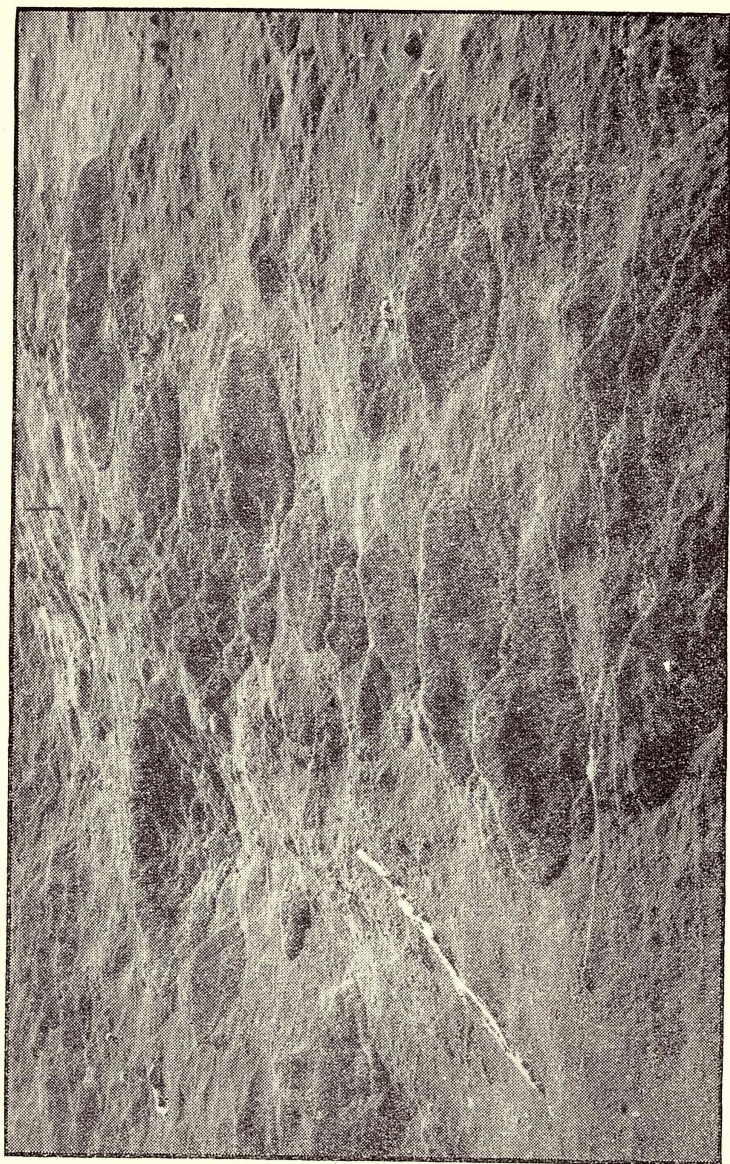
To ensure a complete kill in one season a follow-up spray of the green areas of the plant, that is, of parts missed in the first operation, should be made about 2 months later.

Carrier or spreader for 2,4,5-T: As for the treatment of blackberry, the most effective carrier for 2,4,5-T in the treatment of gorse is water, except for the stump treatment. If aromatic oils such as diesel fuel oil or kerosene are used in spraying other than seedling gorse, a quick scorching of the foliage occurs with resultant rapid recovery. For regrowths of established gorse a slow foliage check is required for positive control. On the other hand kerosene or diesel fuel oil used as a carrier and penetrant in the stump method has given excellent results.

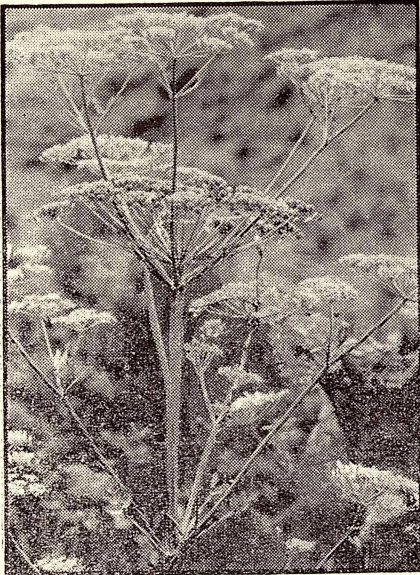
Formulations: Both volatile and low-volatile oil-soluble esters have given consistently good results where complete coverage has been achieved. Mixtures give results closely proportional to the 2,4,5-T content, and though there is some movement of 2,4-D in gorse, its addition to 2,4,5-T in a mixture is not economical.

Esters of 4-C have shown no promise for gorse control. The value of 2,4,5-TP acid is still to be determined.

In waste areas gorse has been killed by "Polyborchlorate" and "Atlacide" at rates over 1000lb., by Borascu at rates over 2000lb., and by C.M.U. at rates over 80lb.



Hard fern occupying southern faces of hill country. There is a possibility that regrowths of this fern can be controlled with esters of 4-C.



Seed head of hemlock. The plant is dangerous to animals that are non-ruminants. It is easily recognised by its finely divided, carrot-like leaves and purple spots on the stems and leafy stalks. It can be successfully killed in the early stages of growth by esters of 2,4-D.

Grasses

The subject of grasses is dealt with separately in the section beginning on page 76.

Groundsel

(*Senecio vulgaris*)

Groundsel (*Senecio vulgaris*) is a common annual in gardens and cultivated land throughout New Zealand. It is only slightly susceptible to salts and amines of M.C.P. and 2,4-D as seedlings at rates up to 1lb. Plants are checked or killed up to flowering stage with esters of 2,4-D at rates up to 2lb.

Hard Fern

(*Paesia scaberula*)

Hard fern (*Paesia scaberula*) occupies the shady faces of low fertility pasture areas. It is resistant to the M.C.P., 2,4-D, and 2,4,5-T preparations, but 4-C applied to fresh frond growth

at rates of 4lb. to 8lb. appears satisfactory in initial trial work. The areas should be burnt in autumn, oversown and topdressed, and the young regrowths sprayed the following spring.

Hawkbit

(*Leontodon leysseri*)

A perennial rosette, hawkbit (*Leontodon leysseri*) is plentiful in pastures and waste places throughout New Zealand. In pastures control should be by increasing fertility. In waste places it is killed by salts and amines of M.C.P. and 2,4-D at rates up to 1lb. prior to flowering. In playing greens it is killed by M.C.P., 2,4-D, or 2,4,5-T at rates up to 1lb.

Hawkweed

(*Crepis capillaris*)

Hawkweed (*Crepis capillaris*) is an annual to biennial plant occurring in waste places throughout New Zealand. It is susceptible to salts and amines of M.C.P. and 2,4-D. In playing greens it is killed by M.C.P., 2,4-D, or 2,4,5-T at rates up to 1lb.

Hedge Mustard

(*Sisymbrium officinale*)

Hedge mustard (*Sisymbrium officinale*) is a susceptible annual abundant in waste places and occasionally in open pastures. Seedlings are killed by salts and amines of M.C.P. and 2,4-D at 0.5lb. and plants up to flower-head formation by 1.0lb. Plants up to 4in. high are killed by phenols at 1lb. to 2lb. when occurring in crops; also by pre-emergence applications of hormones and phenols.

Hemlock

(*Conium maculatum*)

Hemlock (*Conium maculatum*) is frequently to locally abundant in waste places throughout New Zealand. A perennial plant, it is killed as seedlings with esters of 2,4-D at 1lb. to 2lb. Established plants should be treated at the late full rosette stage with esters of 2,4-D at 3lb. to 4lb. Plants in seed head are checked or killed by esters of 2,4,5-T at 2lb. to 3lb.

Hoary Cress

(*Cardaria draba*)

Hoary cress (*Cardaria draba*) is a rhizomatous perennial established in cultivated areas in scattered localities in both Islands. Where it is established seedlings and regrowth plants occur together. The seedlings and regrowths, treated at flower stalk initiation, are susceptible to salts and amines of M.C.P. and 2,4-D at 1.0lb. Seedlings are killed by this application, but plants arising from regrowths often recover. Usually annual repeat applications spread over several years are necessary to kill established plants of hoary cress, but it is sufficiently susceptible to be checked in crops such as cereals and potatoes to allow a clean harvest. Plants arising from seedlings up to 4in. high are killed by salts of phenols at 1lb. to 2lb. and by aromatic oils. Seedlings are successfully killed by pre-emergence applications of hormones at 1lb. to 2lb., phenols at 2lb. to 3lb., and urea compounds at 1lb. to 2lb. Oktone at 4lb. plus diesel fuel oil is also satisfactory.

Horehound

(*Marrubium vulgare*)

A semi-woody perennial, horehound (*Marrubium vulgare*) is frequently to locally abundant in waste places in both Islands. It reacts more favourably to esters of 2,4-D than to similar preparations of 2,4,5-T. Seedlings are killed at rates up to 2lb. and established plants at rates of 2lb. to 4lb. Young plants are satisfactorily killed with salts and amines of M.C.P. and 2,4-D at rates of 2lb., but control is poorer than with esters.

Horse Radish

(*Raphanus sativus*)

Horse radish (*Raphanus sativus*) is an annual or biennial growing in waste areas in both Islands. It is very susceptible as seedlings to salts and amines of M.C.P. and 2,4-D at 0.5lb. Older plants are usually killed by one application of salts, amines, and esters of M.C.P. and 2,4-D at 1lb., if applied prior to the seed-head stage. Second-year plants growing from root stocks should be treated at the full leaf stage.

Hydrocotyle Spp.

Hydrocotyle spp. are perennial mat-forming species. Some species are used for playing greens. The tolerance of the various species is not known, but sufficient work has been done to indicate that most species are fairly resistant to water-soluble preparations of M.C.P. and 2,4-D and that repeat sprayings with an ester of M.C.P. or 2,4-D are required for eradication.

Inkweed

(*Phytolacca octandra*)

Inkweed (*Phytolacca octandra*) is a semi-woody perennial growing in waste places in the northern half of the North Island. It is checked or killed as seedlings with the salts and amines of 2,4-D and M.C.P. at 1lb. Semi-mature plants are killed by esters of 2,4-D at 2lb. to 4lb., and mature semi-woody plants should be treated with esters of 2,4,5-T at 2lb. to 4lb. prior to the full flowering stage. As this latter treatment is largely contact in nature a follow-up treatment is necessary for destruction of the plants.

Lupin

(*Lupinus arboreus*)

Lupin (*Lupinus arboreus*) is found in waste places on sandy areas in both Islands. It is resistant in the dicotyledon leaf stage, then is susceptible to esters of 2,4-D up to the semi-woody stage of growth at rates of 1lb. to 2lb. Once in the semi-woody stage of growth plants should be treated with esters of 2,4,5-T at rates of 1lb. to 2lb. In areas of mixed growth stages mixed 2,4-D and 2,4,5-T preparations give satisfactory control. The use of this type of preparation should be avoided in pastures containing lupin, as a severe reduction in clover will result.

Mallow

(*Malva parviflora*)

Mallow (*Malva parviflora*) is a biennial plant abundant in waste places in both Islands. Seedlings are killed by esters of 2,4-D at 1lb.; older plants should be treated prior to the late flowering stage at 1lb. to 2lb.

Manuka*(Leptospermum spp.)*

Manuka (*Leptospermum scoparium*) and kanuka (*L. ericoides*) are not satisfactorily controlled by hormone sprayings. Seedling plants up to 4in. to 6in. are susceptible at rates of 3lb. to 4lb. of 2,4,5-T, provided complete cover is obtained. Unsatisfactory control is obtained when the plants are from 6in. to 18in. high. Plants at this stage of growth have the power of regrowing from the bases. It is fairly definite that 2,4,5-T has only a contact action on the foliage of both species so that plants treated at the 6in. to 18in. stage usually require several applications to control regrowths. The repeat application of 2,4,5-T at rates of 3lb. to 4lb. would eliminate any clover present, so that this treatment is not very practical in young pastures. Over about 18in. high plants lose the power of regrowth from the bases and can be destroyed by a contact action as with a 2,4,5-T application.

Marshmallow*(Althaea officinalis)*

Marshmallow (*Althaea officinalis*) is a perennial plant with restricted distribution. Seedlings are killed by esters of 2,4-D at 1lb.; old plants prior to reaching maturity should be sprayed with esters of 2,4-D at 2lb. to 3lb. A repeat application is possibly necessary.

Matagouri*(Discaria toumatou)*

Matagouri (*Discaria toumatou*) is a much-branched thorny bush or tree occurring locally in the North Island from the Waikato River to Cook Strait. It is common on the eastern side of the Southern Alps of the South Island. This species cannot compete either with improved swards or the introduced sweet brier. It is highly resistant to available M.C.P., 2,4-D, and 2,4,5-T preparations.

Mexican Devil Weed*(Eupatorium adenophorum)*

Mexican devil weed (*Eupatorium adenophorum*) is a perennial plant spreading in waste places in North

Auckland. It is very doubtful if this plant can compete with high fertility pastures. As seedlings it is effectively killed with esters of 2,4-D at 1lb. to 2lb. Mature plants should be treated at the early flowering stage with esters of 2,4-D at 2lb. to 4lb. A follow-up treatment is necessary about 12 months later when the regrowths are at the maximum leaf development. Esters of 2,4,5-T are more severe in their action than 2,4-D, but probably more regrowths occur with the use of 2,4,5-T. More work is required with this species.

Mint*(Mentha spp.)*

Mint (*Mentha* spp.) is infrequent in waste places in both Islands. It is a creeping perennial that requires repeat applications for control. These plants should be treated at the full leaf stage with esters of 2,4-D at 1lb. to 2lb. Repeat treatments should be applied a year later, when leaves on regrowths are fully grown.

Monkey Musk*(Mimulus guttatus)*

Frequently found in the southern half of the North Island and throughout the South Island in damp areas and streams, monkey musk (*Mimulus guttatus*) is a perennial with a creeping rootstock, requiring more than one application for control. The first application should be made just prior to flower-head formation with salts and amines of M.C.P. and 2,4-D at 1lb. Repeat treatments at the same rates should be made annually when leaves on regrowths are fully grown.

Mouse-eared Chickweed*(Cerastium glomeratum)*

Mouse-eared chickweed (*Cerastium glomeratum*) is an annual or biennial plant found in cultivated fields and thin pastures throughout both Islands. Seedlings are checked or killed with esters of 2,4-D at rates up to 1lb. Older plants are checked slightly. This weed shows too much resistance to be killed in hormone tolerant crops such as cereals or potatoes. It is killed up to 4in. high by salts of phenols at 1lb. to 2lb. or up to the flowering stage by

phenols activated by aromatic oils. It is successfully controlled at pre-emergence by hormones at 1lb. to 2lb. and phenols at 2lb. to 3lb., C.I.P.C. at 2lb. to 4lb., and by Oktone at 4lb. in diesel fuel oil.

Mouse-ear Hawkweed

(*Hieracium pilosella*)

A perennial established in scattered areas in southern Canterbury, mouse-ear hawkweed (*Hieracium pilosella*) is susceptible to salts and amines of M.C.P. and 2,4-D at 1lb. to 2lb., but plants require repeat treatment for destruction. Regrowths or plants arising from suckers should be treated at full leaf stage.

Musky Storksbill

(*Erodium moschatum*)

Musky storksbill (*Erodium moschatum*) is common in dry, waste places; less frequent in open pastures. An annual or biennial plant killed in the seedling stage with salts and amines of M.C.P. and 2,4-D at 1lb.; older plants prior to seed head are more effectively killed by esters of 2,4-D at 1lb.

Muehlenbeckia australis

Muehlenbeckia australis is common throughout New Zealand. A much-branched woody perennial, it is susceptible to esters of 2,4,5-T at 3lb. to 4lb., but requires repeat applications for control. Well-established plants can be killed by applying 2,4,5-T plus diesel fuel oil in the ratio of 1:80 to the base of the plant or alternatively frilling the base of the plant near ground level and applying a 1:20 mix of above.

Nertera dichondraefolia

Nertera dichondraefolia is a matted perennial found throughout New Zealand. It is susceptible to salts and amines of M.C.P. and 2,4-D, but repeat treatments are required for destruction of plants.

N.Z. Flax or Phormium

(*Phormium tenax*)

N.Z. flax or phormium (*Phormium tenax*) is fairly resistant to water-soluble preparations of M.C.P., and

2,4-D at rates of 1lb. to 2lb. It is killed by esters of 2,4-D or 2,4,5-T at rates of 3lb. to 4lb., particularly if applied in diesel fuel oil.

Nodding Thistle

(*Carduus nutans*)

Nodding thistle (*Carduus nutans*) is a biennial plant occurring in South Canterbury, Otago, and also Hawkes Bay. It is killed by salts and amines of M.C.P. and 2,4-D as seedlings at rates up to 1lb. It is susceptible up to the flowering stage to rates up to 2lb., but much less smothering of the pasture occurs if the application is made before the thistles are fully grown.

Nutgrass

(*Cyperus rotundus*)

A perennial with tuberous rootstocks, well established about Auckland, nutgrass (*Cyperus rotundus*) is controlled by esters of 2,4-D applied at 2lb. to 3lb. when the nutgrass is making fresh spring growth and the leaves are still soft and succulent. Other chemicals such as T.C.A. and C.M.U. are more suitable for its control. The T.C.A. should be applied at rates of 60lb. to 80lb. after cultivation and when the regrowths are up to 2in. high. C.M.U. should be applied under the same conditions at rates of 30lb. to 40lb. As this rate renders the ground sterile for a considerable period control by C.M.U. should be limited to waste areas.

Onehunga Weed

(*Soliva sessilis* and *S. valdiviana*)

Onehunga weed (*Soliva sessilis* and *S. valdiviana*) occurs commonly in waste places and playing greens and lawns from Marlborough and Nelson northwards. Susceptible annuals are killed as seedlings with salts and amines of M.C.P. and 2,4-D at 1lb. The weed is also killed by 2,4,5-T, if this material is being used for clover control in playing areas. These species germinate in autumn and spring. Areas infested should be oversown and fertilised and then a light application of hormone used immediately after the sowing. If this is done, the sown

species will help to arrest further infestation.

***Oxalis* Spp.**

Control of *Oxalis* spp. by hormone preparations is not satisfactory. The top growth can be killed to ground level, but fresh growth comes away. Control by C.M.U. is poor unless the area is frequently cultivated; rates of 20lb. to 40lb. are required. The best control is obtained by using borax or chlorate at 1lb. per square yard. This treatment has the disadvantage of rendering the soil sterile for up to 6 months and does not kill dormant bulbs, so that repeat applications are necessary. The chemical control of this weed is not satisfactory.

Ox-eye Daisy

(*Chrysanthemum leucanthemum*)

Ox-eye daisy (*Chrysanthemum leucanthemum*) is common to locally abundant in damp pastures and waste places in both Islands. A perennial plant, it is killed at the seedling stage with esters of 2,4-D and M.C.P. at 1lb. to 2lb. Once it is established repeat applications are required for control. Esters of M.C.P. are possibly more

toxic than the corresponding esters of 2,4-D. Regrowth plants should be treated in full leaf. This plant doubtfully competes with good pastures and pasture improvement is probably the better method of control.

Ox Tongue

(*Helminthia echioides*)

A susceptible annual, ox tongue (*Helminthia echioides*) grows occasionally in waste places in both Islands. Up to flowering stage it is killed by salts and amines of M.C.P. and 2,4-D at rates up to 1lb.

Parsley Dropwort

(*Oenanthe pimpinelloides*)

Parsley dropwort (*Oenanthe pimpinelloides*) is confined to few areas such as Victoria Valley, Kaitaia, Mission Bay, Auckland, etc.

A semi-tolerant perennial it requires repeat applications of esters of 2,4-D at 2lb. for control. The first application should be made when the plant is approaching flower-head formation. Annual applications should then be made when the regrowths have reached full leaf development.

Pearlwort

(*Sagina procumbens*)

Pearlwort (*Sagina procumbens*) is a perennial forming little mats; it occurs throughout New Zealand in waste places and playing greens. It is very tolerant; doubtfully controlled by any available preparation of M.C.P. and 2,4-D or 2,4,5-T. More work is required with esters of M.C.P. and 4-C.

Pennyroyal

(*Mentha pulegium*)

Pennyroyal (*Mentha pulegium*) is a common weed in damp pastures and waste places in both Islands. Seedlings are killed by 0.5lb. to 1lb. of salts and amines of M.C.P. and 2,4-D. Established plants should be treated when approaching flower-head formation with rates from 1lb. to 1.5lb. of the above treatments. The application should be made when the area is still damp and the pennyroyal growing vigorously. If the area dries out



Pennyroyal should be treated in pastures with the salts and amines of M.C.P. and 2,4-D prior to the flower-head formation.

through summer, the pennyroyal persists, but becomes extremely tolerant to hormone sprays.

Periwinkle

(*Vinca major*)

A perennial, periwinkle (*Vinca major*) grows frequently in waste places in both Islands. Control is possible only with repeat applications of esters of 2,4-D and diesel fuel oil. The rate should be 2lb. in sufficient aromatic oil to give a thorough coverage. Repeat applications should be made when the regrowths have reached maximum leaf development. Further work is required with other chemicals.



Ragwort should be treated prior to the flower-head formation with salts and amines of M.C.P. and 2,4-D.

Plantains

(*Plantago* spp.)

Buck's horn plantain (*Plantago coronopus*), rib-grass (*P. lanceolata*), greater plantain (*P. major*), and hoary plantain (*P. media*) are all up to the flowering stage quite susceptible to salts and amines of M.C.P. and 2,4-D at rates up to 1lb. Most species are perennials, and regrowth plants should be treated at maximum leaf development. In pastures control should be by increasing fertility and in low fertility areas such as lawns and playing greens the best control is obtained with hormone preparations. In these latter areas plantain species are not killed by 2,4,5-T unless repeat applications are made. In waste areas rates of over 40lb. of C.M.U. are required for control.

Purslane

(*Portulaca oleracea*)

Purslane (*Portulaca oleracea*), an annual, is more common in the north of the North Island than the south of the North Island. As seedlings it is killed with esters of 2,4-D at rates up to 2lb. Mature plants show a high degree of resistance.

Ragwort

(*Senecio jacobaea*)

Ragwort (*Senecio jacobaea*) is a perennial distributed widely in both Islands in pastures and waste places. The best control is obtained by using the salts and amines of M.C.P. and 2,4-D at rates of up to 2lb. when the ragwort is at the maximum rosette stage. Possibly M.C.P. is slightly more toxic than the corresponding preparations of 2,4-D. In the late flowering stage ragwort is fairly resistant to water-soluble preparations and should be treated with esters of 2,4-D at rates up to 2lb. Good control can also be obtained by mowing the ragwort in flower head and treating the regrowth plants at the rosette stage with the salts and amines of M.C.P. and 2,4-D. This has the advantage of allowing all the ragwort to be treated at the same growth stage. In most cases a repeat application is necessary to kill surviving regrowths. These should be treated at the full rosette stage.



Red root in crops is more susceptible to salts and amines of 2,4-D than M.C.P.
It can also be successfully controlled by pre-emergence applications.

Raupo

(*Typha angustifolia*)

A perennial abundant in marshy places throughout New Zealand, raupo (*Typha angustifolia*) should be treated when 3ft. to 5ft. high, that is well before flower stalk initiation. If it is treated at this stage with up to 8lb. of ethyl ester 2,4-D, fairly satisfactory control is obtained. If it is treated later than this stage, an aromatic oil such as diesel fuel oil must be added to give penetration. Possibly the best material to employ at the later stages of growth is a solution of ester in oil (such as aero concentrate). Diesel fuel oil is used as the carrier. Repeat applications should be made when the regrowths are 3ft. to 5ft. high.

Red Clover

(*Trifolium pratense*)

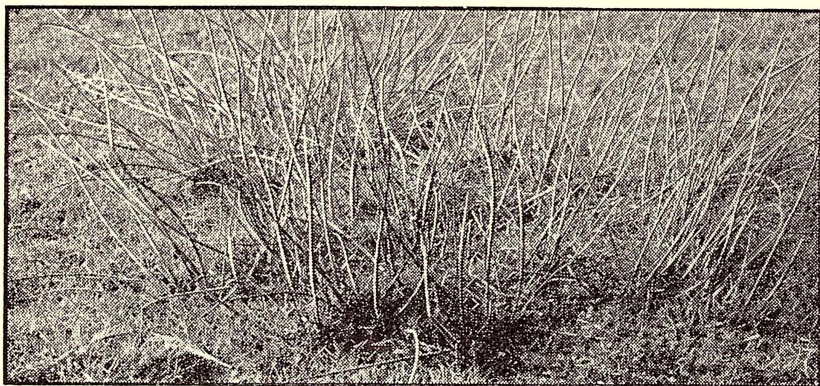
Red clover (*Trifolium pratense*) is killed as seedlings with 2,4-D ester at 1lb. to 2lb. All stages of growth are killed with ester of 2,4,5-T; seedlings

1lb., established plants 1lb. to 2lb. In crops it is only satisfactorily controlled by pre-emergence applications of hormones at 2lb. to 4lb. or by urea compounds at 2lb. to 5lb. In waste areas it has been killed by C.M.U. at rates over 30lb.

Red Dead Nettle

(*Lamium purpureum*)

An annual common in cultivated ground and waste places from the northern half of the South Island northwards, red dead nettle (*Lamium purpureum*) is checked or killed by salts and amines of M.C.P. and 2,4-D at rates up to 1lb. at the seedling stage of growth. A higher rate of application is sometimes necessary for plants at the flowering stage. Up to 4in. high it is killed by salts of phenols at rates of 1lb. to 2lb. and by aromatic oils. It is successfully killed as germinating seedlings by pre-emergence applications of hormones at 2lb. to 3lb., phenols at 2lb. to 4lb., C.I.P.C. at 2lb. to 4lb., and urea compounds at 2lb.



Juncus effusus, the soft rush with a solid stem, is readily grazed by cattle. The regrowths of this rush from 12in. to 18in. high are killed by 2,4-D preparations.

to 4lb. T.C.A. at 20lb. to 30lb. shows a depressing effect.

Red Root

(*Amaranthus*, mainly *Amaranthus retroflexus*)

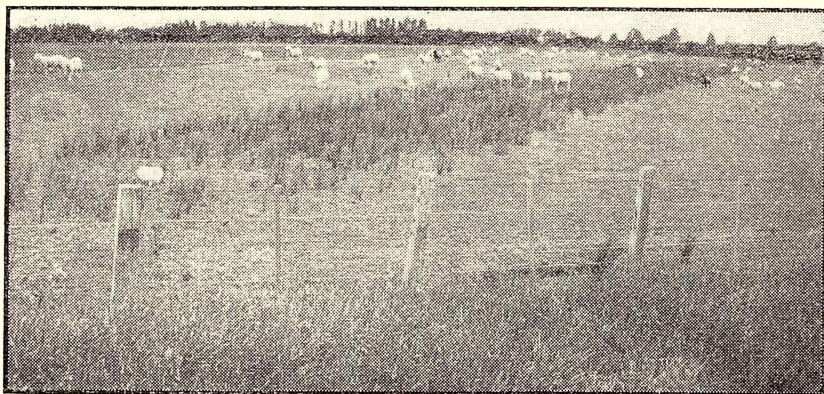
Red root (*Amaranthus*, mainly *Amaranthus retroflexus*) is fairly widely distributed in cultivated land and waste places throughout New Zealand. It is largely killed by salts and amines of M.C.P. and 2,4-D at rates up to 1lb. The application should be made at the seedling stage of growth, as this weed cannot be selectively killed once fully established. Preparations of 2,4-D are possibly more toxic than preparations of M.C.P.

Up to 3in. high it is killed by salts of phenols at rates of 1lb. to 2lb. and by aromatic oils. It is successfully killed as germinating seedlings by pre-emergence applications of hormones at 1lb. to 2lb., phenols at 2lb. to 4lb., C.I.P.C. at rates over 4lb., urea compounds at 2lb. to 4lb., and T.C.A. at 10lb. to 15lb. It is also killed by Oktone at 4lb. plus diesel fuel oil.

Red Shank or Willow Weed

(*Polygonum persicaria*)

Red shank or willow weed (*Polygonum persicaria*) is common in cultivated areas and damp places throughout New Zealand. It is only slightly checked by preparations of M.C.P. and



Rushes cannot compete with a good pasture as shown in this photograph. The middle block was sown with a species of grass that did not establish.

2,4-D up to 1lb., amines of 2,4-D being slightly better than other preparations. It shows too much resistance to be selectively checked in hormone tolerant crops such as cereals and potatoes. Treatment of smartweed (*Polygonum hydropiper*) is identical to the above species. It is killed by salts of phenols at 1lb. to 2lb. in the seed leaf stage of growth. Aromatic oils are also satisfactory. It is also successfully controlled by pre-emergence applications of hormones at 1lb. to 3lb., phenols at 2lb. to 4lb., C.I.P.C. at 2lb. to 4lb., and T.C.A. at 15lb. to 20lb. Excellent control has been obtained with Oktone at 4lb. plus diesel fuel oil and urea compounds at 2lb. to 4lb.

Rushes

(*Juncus* spp.)

Juncus effusus, the soft rush, is the species most readily killed with hormone preparations, the best control being obtained with the amines and ester of 2,4-D at 2lb. It is possibly the only species that does not require cutting prior to spraying. Severe grazing is probably sufficient. The regrowths should be treated when 15in. to 18in. high. *J. pallidus* is the next in order of susceptibility, but provided it is mown in spring and sprayed when

the regrowths are 18in. to 2ft. high with amines and esters of 2,4-D at 2lb., then good control follows. *J. polyanthemus* and *J. luxurians* are controlled by mowing and treating the regrowths when 12in. to 18in. high with ester of 2,4-D at 2lb. *J. vaginatus* is probably controlled by the same method, but further work is required. No trials to date have been put down on *J. pauciflorus*. The spray application must be made after mowing and before the dry weather sets in; otherwise the rush stems become hard and poor control results. Rushes are difficult to wet. Best results are obtained by applying a finely atomised spray in the early morning when the convection currents are downwards and small particles are less likely to become windborne. Particles of large droplet size fail to adhere to the cylindrical stems of rushes. The rush species that grow in damp areas (*J. articulatus*, *J. holoschoenus*, and *J. prismatocarpus*) have been successfully killed in dampish areas by rates of C.M.U. over 40lb.

Russian Knapweed

(*Centaurea repens*)

A rhizomatous perennial confined to one area near Blenheim, Russian knapweed (*Centaurea repens*) is best



Russian knapweed, showing regrowths after treatment with 2 tons of sodium chlorate. Ryegrass and clover were killed at this rate.



Juncus polyanthemus (upper left) and *J. luxurians* (lower left) are intermediate in resistance. Both require prior cutting. The regrowths should be sprayed when 12in. to 18in. high. These rushes are more wiry and the stems are difficult to break. *J. pallidus* (upper right), a very tall growing rush with solid stems, is also readily killed by spraying the regrowths after mowing when 18in. to 24in. high with esters of 2,4-D. *J. vaginatus* (lower right) is not common. It is identified by having a hollow stem. It is doubtfully controlled by hormone preparations.



A mature Scotch thistle. This plant is readily controlled by salts and amines of M.C.P. and 2,4-D. The application should be made as near to the seedling stage of growth as possible.

treated at the maximum rosette stage with salts and amines of M.C.P. and 2,4-D at 2lb. At later stages, that is, flower and seed head stage, esters of 2,4-D should be employed at rates up to 2lb. Regrowths should be treated in the rosette stage.

Saffron Thistle

(*Carthamus lanatus*)

Saffron thistle (*Carthamus lanatus*) is an annual occurring in several scattered localities, mainly in the North Island, but more recently in the South Island. It is susceptible to salts and amines of M.C.P. and 2,4-D at

rates of 0.5lb. to 1lb. as seedlings. Higher rates are required up to the flower-head stage.

Scarlet Pimpernel

(*Anagallis arvensis*)

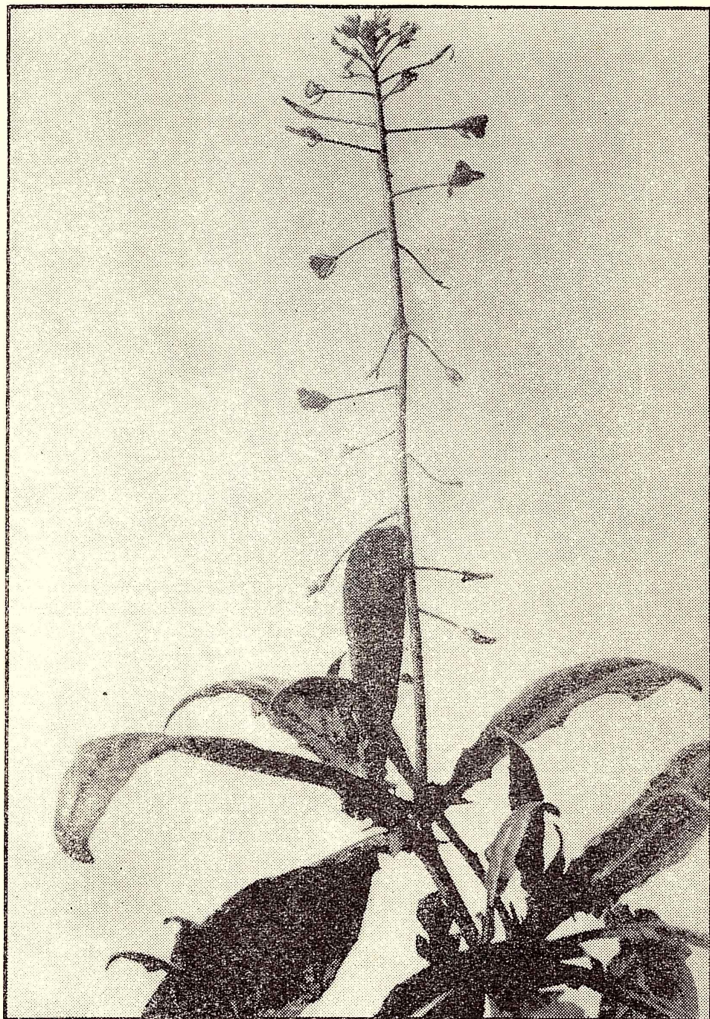
Scarlet pimpernel (*Anagallis arvensis*) is a straggling annual common in waste places and cultivated land throughout New Zealand. In waste places it is killed by esters of 2,4-D at 1lb. and in crops it is checked or killed by salts and amines of M.C.P. and 2,4-D at 1lb. Up to the 2 to 3 leaf stage it is successfully killed by salts of phenols at 1lb. to 2lb.

Scotch Thistle

(*Cirsium lanceolatum*)

A biennial plant common in waste places and pastures throughout New Zealand, Scotch thistle (*Cirsium lanceolatum*) competes freely with high fertility pastures. Control of this weed is best secured with hormone weedkillers. Seedlings are very susceptible to salts and amines of 2,4-D and M.C.P.

at rates of 0.5lb. Control can be secured up to the full-grown rosette stage with salts and amines of M.C.P. and 2,4-D at 1lb. to 2lb. After this stage esters of 2,4-D should be employed at rates up to 1lb. Second-year plants should be treated at the maximum rosette stage. The weed has been killed at the seed leaf stage by salts of phenols at 1lb. to 2lb. in crops. In waste areas established



Shepherd's purse, a plant susceptible to hormone weedkillers and readily controlled in hormone tolerant crops.

plants require rates of C.M.U. over 20lb. for control.

Self Heal

(*Prunella vulgaris*)

Self heal (*Prunella vulgaris*) is common in damp pastures and waste places throughout New Zealand. It is a perennial doubtfully killed with one application of salts and amines of M.C.P. and 2,4-D at 1lb. The application should be made prior to the flower-head formation. A repeat application should be made to destroy regrowths when the regrowths have reached full leaf development.

Sheep's Sorrel

(*Rumex acetosella*)

Abundant throughout New Zealand in waste places and cultivated land, sheep's sorrel (*Rumex acetosella*) shows too much tolerance to be effectively destroyed with hormone preparations. Most preparations, particularly the amines of 2,4-D, check sorrel, but recovery is soon complete.

Shepherd's Purse

(*Capsella bursa-pastoris*)

Shepherd's purse (*Capsella bursa-pastoris*) occurs in cultivated areas throughout New Zealand. A very susceptible annual destroyed at rates of 0.5lb. to 1lb. salts and amines of M.C.P. and 2,4-D. It can be selectively destroyed in hormone tolerant crops such as potatoes. It is effectively killed up to 3in. high by salts of phenols at 1lb. to 2lb. and by aromatic oils. It is susceptible to pre-emergence treatments of hormones at 1lb. to 2lb., phenols at 2lb. to 3lb., urea compounds at 2lb. to 4lb., and Alanap at 2lb. to 4lb. Poor control has been obtained with C.I.P.C. at rates over 4lb. and T.C.A. at rates up to 30lb. Oktone at 4lb. plus diesel fuel oil has given excellent control.

Silver Poplar

(*Populus alba* var. *nivea*)

Suckers up to 6ft. to 10ft. high of silver poplar (*Populus alba* var. *nivea*) are effectively destroyed by an over-all application of 2,4-D and water applied in the late summer

months. Up to 6lb. of material is required, depending on the density of the infestation. Older suckers with green bark at the base of the bole are effectively destroyed by applying a mixture of 2,4-D ester and diesel fuel oil (or other aromatic oil) at 1:80 to the base of the bole. An area of approximately twice the diameter of the tree from ground level upwards should be covered. For limited areas the application may be made with a paint brush. For larger areas the material can be sprayed on. This type of application can be made at any time of the year, but best results are probably obtained by applying the material just before the onset of spring growth. For mature trees or trees with thick corky bark at the bases of the boles, greatest conservation of material can be made if the trees are frilled and a concentrated solution of 1:10 applied to the frills. The frill is best made with Cordtex (a plastic detonating fuse containing an explosive charge). The frill can also be made with a light axe, but the incisions should not be any deeper than the roughened bark. If the cuts are too deep, then the movement of food and water is interrupted and control is not as good. If Cordtex is employed, better results are probably obtained by applying ester of 2,4-D in water to the frill. Further work may show that good results may be obtained by applying salts and amines of 2,4-D to the frill.

Sow Thistle

(*Sonchus oleraceus*)

Sow thistle (*Sonchus oleraceus*) occurs in cultivated land in both Islands, less frequently in waste places. It is a fairly susceptible annual which is killed as seedlings with 0.5lb. to 1lb. of the salts and amines of M.C.P. and 2,4-D. It shows susceptibility up to flower-head formation at rates of 1lb. to 1.5lb. It has been killed in crops at the seed leaf stage by salts of phenols at 1lb. to 2lb.

Spanish Heath

(*Erica lusitanica*)

Spanish heath (*Erica lusitanica*) is rather similar to tree heath (*E. arborea*). It is a woody perennial

spreading in several localities in both Islands. Esters of M.C.P. and 2,4-D are more toxic than similar preparations of 2,4,5-T. Best control is probably obtained by applying esters of M.C.P. and 2,4-D in diesel fuel oil in late summer and early autumn. A repeat spraying to destroy any regrowths a year later is necessary if the area is not stocked. If the area is stocked after the application, subsequent regrowths are usually destroyed by stocking.

Speedwell

(*Veronica arvensis*)

Common in waste places and fields in both Islands, Speedwell (*Veronica arvensis*) is a moderately tolerant annual checked or killed at the seedling stage with 1lb. to 2lb. of the salts and amines of M.C.P. or 2,4-D. It is checked or killed at later stages of growth with esters of 2,4-D at 1lb. to 2lb., but is most effectively killed in the seedling stage by salts of phenols at 1lb. to 2lb. Pre-emergence applications of hormones at 2lb. to 4lb. have been satisfactory; other materials such as phenols, T.C.A., and urea compounds used at selective rates have not given good control. C.I.P.C. has been satisfactory at rates over 4lb. Oktone and diesel fuel oil are satisfactory as a pre-emergence treatment.

Spider Wort or Himalayan Honey-suckle

(*Leycesteria formosa*)

Spider wort or Himalayan honey-suckle (*Leycesteria formosa*) is a small shrub established in waste places particularly forest margins in both Islands. Younger shrubs are susceptible to esters of 2,4-D at 2lb. to 4lb. Mature, woody plants are possibly more effectively killed by 2,4,5-T applications. Mature bushes are possibly best burnt and the regrowths treated when 3ft. to 4ft. high.

Spurrey

(*Spergula arvensis*)

Spurrey (*Spergula arvensis*) is plentiful throughout cultivated land, particularly in the South Island. A moderately tolerant annual, it is

checked or killed with salts and amines of M.C.P. at rates up to 1lb. in the seedling stage of growth. Once more than several inches high it shows too much tolerance to be selectively killed. M.C.P. is more toxic than 2,4-D preparations. Further work is required with preparations of 4-C, which appear promising. Excellent control has been obtained by salts of phenols at 1lb. to 2lb. at the 2in. stage of growth; also by pre-emergence applications of hormones at 2lb. to 4lb., phenols at 2lb. to 4lb., carbamates particularly C.I.P.C. at 2lb. to 3lb., urea compounds at 2lb. to 4lb., and T.C.A. at 20lb. to 30lb. Alanap has also shown promise and excellent control has been obtained by Oktone at 4lb. plus diesel fuel oil.

Spur Valerian

(*Kentranthus ruber*)

Often frequent in waste places in both Islands, spur valerian (*Kentranthus ruber*) is a susceptible perennial controlled by esters of 2,4-D at 1lb. to 2lb. A repeat treatment is possibly necessary for final eradication. The first application should be made just prior to flower-head formation.

St. John's Wort

(*Hypericum perforatum*)

St. John's wort (*Hypericum perforatum*) is found in scattered localities in waste places in both Islands; more frequent in the South Island. It shows susceptibility to esters of 2,4-D at 1lb. to 2lb., but requires repeat applications for control. Regrowths should be treated at maximum leaf development.

Stagger Weed

(*Stachys arvensis*)

An annual common in waste places and cultivated land in the North Island, stagger weed (*Stachys arvensis*) is checked or killed as seedlings by the salts and amines of M.C.P. and 2,4-D at rates up to 1lb. It is killed by esters of 2,4-D at 1lb. up to the flowering stage. At the seed leaf stage it is killed by phenols at 1lb. to 2lb. The tolerance to pre-emergence applications is not known.

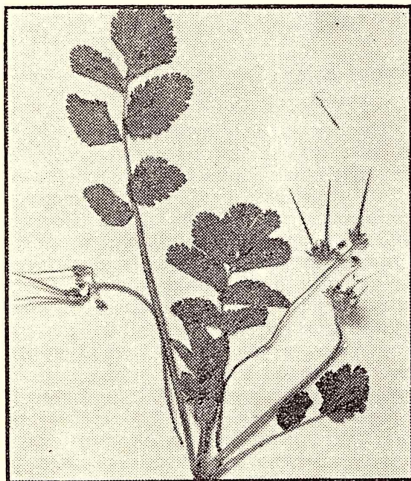


Stinking mayweed is a difficult weed to kill except as seedlings with the present available hormones.

Stinging Nettle

(*Urtica dioica*)

Stinging nettle (*Urtica dioica*) is a perennial uncommon in waste places in both Islands. Seedlings and re-



Storksbill causes damage to sheep pelts. Up to the flowering stage it can be successfully treated with the salts and amines of M.C.P. and 2,4-D.

growth plants up to maximum leaf development are susceptible to salts and amines of M.C.P. and 2,4-D at 1lb. to 2lb. Established plants up to the flowering stage are probably best controlled by esters of 2,4-D at 1lb. to 2lb. Repeat applications are necessary. Regrowths should be treated at maximum leaf development. In crops the weed up to the 2in. stage of growth has been killed by phenols at 1lb. to 2lb. and by aromatic oils. The tolerance to pre-emergence applications is not known.

Stinking Mayweed

(*Anthemis cotula*)

Stinking mayweed (*Anthemis cotula*) is an ill-smelling annual occasionally to locally abundant in waste places and cultivated land in both Islands. It is checked or killed by the salts and amines of M.C.P. and 2,4-D as seedlings by rates of 1lb. to 2lb. M.C.P. is possibly more toxic than 2,4-D. The spray should be atomised as much as possible in order to get good coverage. Established plants up to the flowering stage are doubtfully controlled by esters of 2,4-D at 1lb. to 2lb. Further work is required with esters of M.C.P.



Sweet brier is difficult to control. Several annual applications of esters of 2,4,5-T are required. The first application should be applied at flower-bud formation.

It has been killed in crops by the salts of phenols at 1lb. to 2lb. at the seedling stage of growth.

Storksbill

(*Erodium cicutarium*)

Storksbill (*Erodium cicutarium*) is a hardy annual common in waste places and open pastures in both Islands. It is killed as seedlings by salts and amines of M.C.P. and 2,4-D at 0.5lb. to 1lb. Plants are killed up to the flowering stage at rates up to 1lb.

Subterranean Clover

(*Trifolium subterraneum*)

An annual of restricted distribution, subterranean clover (*Trifolium subterraneum*) is more difficult to control than white or red clover. It is killed as seedlings by esters of 2,4,5-T at 1lb. to 2lb.; older plants are checked or killed by 2lb. to 4lb. It may also be killed by esters of 4-C as seedlings, but further work is required on the tolerance of established plants.

Suckling Clover

(*Trifolium dubium*)

Suckling clover (*Trifolium dubium*)

is an annual abundant in dry, poor pasture and waste places throughout New Zealand. It is killed as seedlings by esters of 2,4-D or 2,4,5-T at 1lb. Mature plants are killed by 2,4,5-T at 1lb. to 2lb.

Sweet Brier

(*Rosa eglanteria*)

The perennial sweet brier (*Rosa eglanteria*) is increasing rapidly in areas where rabbits have been eliminated, particularly in the tussock country of the South Island. Control with the present available preparations is not satisfactory. In unstocked areas up to three applications are necessary to eradicate plants. The first application should be made at the flowering or pip stage. Repeat applications should be made when the regrowths have reached full leaf development. Of the 2,4,5-T preparations the butyl and butoxy ethanol esters have given the best results at rates up to 3lb. to 4lb. The polyethylene glycol ester of 2,4,5-T has not given as good results as the oil-soluble esters. In stocked areas one application may be sufficient to control isolated plants.

A basal application of esters of 2,4,5-T and diesel fuel oil applied in the ratio of 1lb. : 40 gallons of oil to isolated bushes is also satisfactory. The application should preferably be made before the onset of spring growth. Further work is required with 2,4,5-T preparations. Spot treatments of C.M.U. at 8 grammes per plant show distinct promise.

Tansy

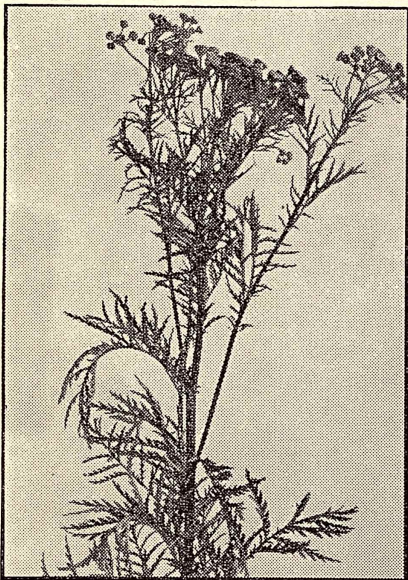
(*Tanacetum vulgare*)

Tansy (*Tanacetum vulgare*) is confined to a few waste places in both Islands. A semi-tolerant perennial, it requires repeat applications for destruction. If it is sprayed near the full rosette stage, salts and amines of M.C.P. and 2,4-D secure the best results at rates of 2lb. to 3lb. If it is sprayed near the flower-head formation, the esters of 2,4-D and M.C.P. at rates of 2lb. to 3lb. give the best control. Regrowths should be sprayed at full leaf development.

Tarweed

(*Odontites viscosa*)

Locally abundant in damp pastures and waste places in both Islands, tar-



Tansy occupies waste ground. It does not compete with a good pasture.

weed (*Odontites viscosa*) is an annual that occupies bare ground in poor pasture. Control should be by improving farming methods rather than by hormone sprays. It is susceptible to salts and amines of M.C.P. and 2,4-D only as seedlings at 1lb. to 2lb. Plants up to flower-head formation are killed by esters of 2,4-D at 1lb. to 2lb.

Tauhinu

(*Pomaderris phyllicaeifolia*)

Tauhinu (*Pomaderris phyllicaeifolia*) is a small heath-like shrub 1ft. to 4ft. high occurring from the North Cape to Otaki and Cape Palliser; it is quite readily killed by esters of 2,4,5-T at 2lb. to 3lb. applied during summer. A repeat application is sometimes necessary. It is also readily controlled by raising the fertility.

Tauhinu-korokio

(*Cassinia leptophylla*)

Often referred to as tauhinu, tauhinu-korokio (*Cassinia leptophylla*) is a woody perennial not uncommon from the East Cape southwards to Marlborough and Nelson. This weed may be confused with *Pomaderris phyllicaeifolia* also known as tauhinu. It is killed as seedlings by esters of 2,4,5-T at 3lb. to 4lb. This is possibly only a contact effect, as semi-mature and mature plants are highly resistant. Much more work is required on this species. Probably the most suitable method of control is by improved farming methods, as it is doubtful if this species will compete under high fertility conditions.

Teasel

(*Dipsacus silvester*)

A biennial plant more frequent in the North Island than the South Island, teasel (*Dipsacus silvester*) is only occasionally found in good pastures and is probably not a serious competitor with this type of pasture. It is readily killed as seedlings with esters of 2,4-D at 1lb. Second-year plants should be treated from the rosette stage up to early flowering stage with 1lb. to 2lb. of esters of 2,4-D.

Thorn Apple

(*Datura stramonium*)

Thorn apple (*Datura stramonium*) is an annual occurring occasionally in



Wild teasel is not often prevalent in pastures. It may be killed prior to flower-head formation with esters of 2,4-D.

waste places and cultivated land in the North Island and as far south as Timaru on the eastern side of the South Island. It is checked or killed as seedlings with esters of 2,4-D at 1lb. to 2lb. The plants show slight sus-

ceptibility up to flower-head formation to esters of 2,4-D at 1lb. to 2lb. They are too resistant to be controlled in hormone tolerant crops. Its tolerance to pre-emergence applications of chemicals is not known.



Tutsan when established requires repeat applications of esters of 2,4,5-T for control. Young plants are successfully controlled by esters of 2,4-D.

Tutsan

(*Hypericum androsaemum*)

A semi-woody perennial, tutsan (*Hypericum androsaemum*) is occasionally to locally abundant in waste places in both Islands. Established plants require repeat applications of esters of 2,4,5-T for control at rates up to 2lb. The first application should be made when the plants are flowering; regrowths should be treated when at the maximum leaf stage. Young plants are killed by esters of 2,4-D at 2lb. to 3lb.

Tutu

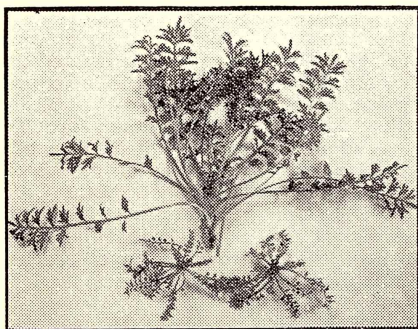
(*Coriaria* spp., mainly *C. sarmentosa*)

Tutu (*Coriaria* spp., mainly *C. sarmentosa*) is susceptible to 2,4,5-T application at 2lb. to 3lb., but repeat applications are required for control. The first application should be made when the plants are flowering or in early fruit. Regrowths should be treated about a year later when at the maximum leaf stage. Like *C. arborea* (the tree species) the low-growing species is probably also poisonous and should not be grazed by stock for 4 to 6 days after being treated.

Twin Cress or Land Cress

(*Coronopus didymus*)

An annual common in waste places and young pastures, twin cress or land



Twin cress is very susceptible to salts and amines of M.C.P. and 2,4-D. If the weed is sprayed, dairy stock should not be allowed to graze it until it is dead, as hormone treatments do not affect the toxin that taints dairy produce.

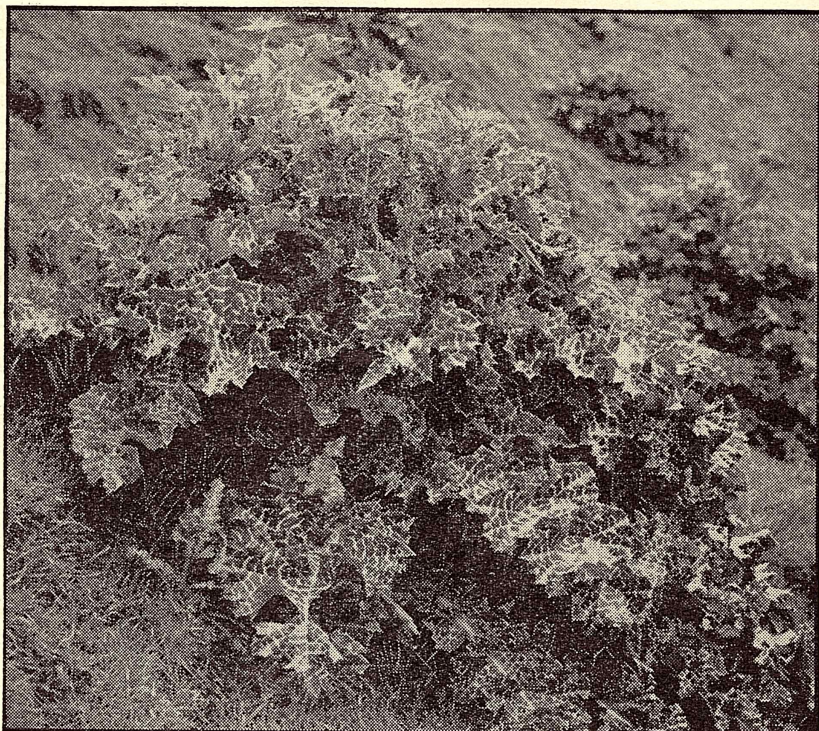
cress (*Coronopus didymus*) seedlings are killed by the salts and amines of M.C.P. and 2,4-D at rates from 0.5lb. to 1lb. Plants show susceptibility up to flower-head formation to these rates. Plants should not be grazed for 4 to 6 days after spraying, as hormone treatments do not affect the toxin which causes the taint in dairy produce. Plants are killed up to the 2in. to 3in. stage by salts of phenols applied at 1lb. to 2lb. and by aromatic oils. The plant is successfully destroyed by pre-emergence applications of hormones at 2lb. to 4lb., and phenols at 2lb. to 4lb., but shows a high resistance to the carbamates and T.C.A. Urea compounds at 2lb. to 4lb. and Oktone at 4lb. plus diesel fuel oil have given excellent control, and Alanap at 2lb. to 4lb. shows promise.

Variegated Thistle

(*Silybum marianum*)

An annual to short-lived perennial common in waste places and pastures in the North Island, variegated thistle (*Silybum marianum*) is less frequent in the South Island. Very susceptible plants as seedlings, they are killed by 0.5lb. to 1lb. of salts and amines of M.C.P. and 2,4-D. Mature plants require slightly higher rates for control, but in all cases the application should be made while the plant is growing vigorously and before the onset of dry weather. If extremely dry conditions have prevailed before the application and plants are past the maximum rosette stage, up to 2lb. to 3lb. is required. This weed is successfully treated from the air by solutions of 2,4-D and diesel oil under good growing conditions. It can also be treated successfully by the aerial application of hormonised fertilisers, particularly if the surface of the leaf is moist at the time of application and rain does not fall for 3 to 4 days after the application.

Trials have shown that oversowing and topdressing must follow the spraying of variegated thistle; otherwise the area is soon reinfested. In trials two applications have been required a year to keep variegated thistle under control where oversowing and topdressing have not been attempted.



An established plant of variegated thistle. This plant is very easily controlled by salts and amines of 2,4-D. The application should be made as near to the seedling stage as possible.

Vetches or Tares

(*Vicia sativa*)

Vetches or tares (*Vicia sativa*) are common annuals in waste places and crops throughout New Zealand. They are checked or killed as seedlings by salts and amines of M.C.P. and 2,4-D at 1lb., particularly if spray particles are atomised. Older plants are checked sufficiently by these rates to allow a clean harvest of cereals. In waste places mature plants up to flower-head formation can be controlled by esters of 2,4-D or 2,4,5-T at rates of 1lb. to 2lb. They are checked by salts of phenols at 1lb. to 2lb. in the seed leaf stage of growth, and are killed by pre-emergence treatments of hormones at 2lb. to 4lb. and urea compounds at 2lb. to 4lb., but show a high resistance to C.I.P.C. at rates up to 4lb. and T.C.A. at rates up to 20lb.

Watercress

(*Nasturtium officinale*)

A perennial abundant along streams in both Islands, watercress (*Nasturtium officinale*) is very susceptible to preparations of M.C.P. and 2,4-D at 1lb. to 2lb., but repeat applications are required for complete control. The best results are obtained by using water-soluble preparations of M.C.P. and 2,4-D just prior to the flowering stage. A repeat application should be made when the regrowths have reached maximum leaf development.

Water Hyacinth

(*Eichhornia crassipes*)

Water hyacinth (*Eichhornia crassipes*) is limited in distribution from North Auckland to Shannon in the south to still-water areas. A water

weed that propagates very rapidly vegetatively, it is very easily killed by preparations of 2,4-D applied at 4lb. to 8lb. Amines of 2,4-D should preferably be applied in a minimum amount of water so that run-off is avoided. If this method is adopted, a repeat spraying should be made in 8 to 12 days to ensure a complete coverage. The application should not be made later than 8 to 12 days, as little further absorption of the material will take place on leaves severely affected. If esters of 2,4-D are employed, a higher rate of diluent can be employed. If these materials are used, the effect of the first spraying should be apparent before a following treatment is made. The second application should be made before the water hyacinth has had time to recover. Total eradication is probably best done by hand pulling.

As this weed is a serious menace in lakes and waterways, the Department of Agriculture is desirous that it should be eradicated. If reproduction is solely vegetative, then eradication is feasible. In the warmer areas there is some evidence that plants may develop from seeds. If this occurs, then eradication will be more difficult.

White Clover

(*Trifolium repens*)

White clover (*Trifolium repens*) is a perennial with stems that creep and root. Seedling plants are killed by esters of 2,4,5-T at 1lb. with one application. Once established and stems have spread and rooted it is doubtfully killed by one application of 2,4,5-T at 2lb. to 3lb. Repeat application is probably necessary once the regrowths have full leaf development. The time of application for the elimination of white clover in playing greens is probably important. If the application is made when the grass is growing vigorously in the cooler, moist months, the effect of reducing the clover is to make the area deficient in available nitrogen unless this is applied. Any damage to the grass will be more marked at this period than during the warmer and drier months when the grass is not growing vigorously and the suppression of the clover gradually leads to a grass response.

In crops white clover is only satisfactorily controlled by pre-emergence

applications of salts of M.C.P. and 2,4-D at rates of 2lb. to 4lb. or urea compounds at rates of 2lb. to 5lb. In waste areas it has been killed by rates of C.M.U. at 30lb.

White Dead Nettle

(*Lamium album*)

A hairy perennial occurring occasionally in both Islands in waste places, white dead nettle (*Lamium album*) is susceptible up to flower-head formation to esters of 2,4-D at 1lb. to 2lb. Plants should be treated when approaching flower-head formation. Repeat treatments are required when regrowths are at full leaf development. It is successfully killed in crops at the seedling stage of growth by salts of phenols at 1lb. to 2lb.

Wild Garlic

(*Allium vineale*)

A bulbous perennial, wild garlic (*Allium vineale*) grows in waste places in the Auckland Province. Germinating bulbs are killed by esters of 2,4-D at 2lb. to 3lb. applied in sufficient diesel fuel oil to secure a complete foliage cover when the spring leaves are 4in. to 6in. high. Repeat applications are necessary to kill successive crops of germinating bulbs.

Wild Mignonette

(*Reseda luteola*)

Wild mignonette (*Reseda luteola*) is an annual or biennial plant, depending on climatic conditions, occurring in waste places in both Islands. It is susceptible as seedlings to salts and amines of M.C.P. and 2,4-D, at rates up to 1lb. Plants are killed up to flower-head formation with esters of 2,4-D at 1lb.

Wild Onion

(*Allium triquetrum*)

A bulbous perennial, wild onion (*Allium triquetrum*) is locally plentiful in damp places in the North Island. Germinating bulbs are killed by esters of 2,4-D at 2lb. to 3lb. applied in sufficient diesel fuel oil to secure a complete foliage cover when the spring

leaves are 4in. to 6in. high. Repeat applications are necessary to kill successive crops of germinating bulbs.

Wild Parsnip

(*Pastinaca sativa*)

A biennial plant naturalised in waste places in both Islands, wild parsnip (*Pastinaca sativa*) is readily killed as seedlings by esters of 2,4-D at 1lb. Established second-year plants should be treated at the full leaf stage with esters of 2,4-D at 1lb. to 2lb. If they are treated prior to the full leaf stage, a repeat application is probably necessary for control.

Wild Spaniard

(*Aciphylla squarrosa*)

Wild spaniard (*Aciphylla squarrosa*) is a perennial occurring in the mountainous areas of the southern half of the North Island to Foveaux Strait, but only troublesome when it descends to the lower altitudes in the South Island. It is killed by high rates of 2,4,5-T applied in summer months. The rate should be 6lb. to 8lb. or a spot treatment of 12,000 p.p.m. applied to wet the plant thoroughly.

Wild Turnip

(*Brassica campestris*)

A very common annual of cropping areas, particularly in the South Island, wild turnip (*Brassica campestris*) is very susceptible to salts and amines of M.C.P. and 2,4-D. It is killed as seedlings by rates up to 0.5lb. and up to the flowering stage by rates up to 1lb.

Up to the 2in. stage it is effectively killed with salts of phenols at 1lb. to 2lb. and by aromatic oils. It is successfully destroyed by pre-emergence applications of hormones at 1lb. to 2lb., phenols at 2lb. to 4lb., and urea compounds at 1lb. to 3lb., and is relatively resistant to T.C.A. at rates up to 30lb. and C.I.P.C. at rates up to 4lb. It is very susceptible to Oktone at 4lb. and diesel fuel oil.

Willows

(*Salix* spp.)

The treatment of crack willow (*Salix fragilis*) and weeping willow (*S. baby-*

lonica) is the same, but pussy willow (*S. caprea*) differs in that it does not develop thick corky bark and frilling is not necessary for its control.

Preparations of 2,4-D rather than 2,4,5-T have given effective willow control. For control willows may be considered at the following three stages of growth.

Seedlings and suckers up to 5ft. of the three species are eradicated best by an over-all spray of 2,4-D oil-soluble ester and water applied in summer at a concentration of 1000 to 2000 p.p.m. (1lb. to 2lb. of acid equivalent in 100 gallons of water). A complete spray cover is essential. Inferior results are obtained especially with regrowths or suckers if the spraying is done in spring when leaf growth is not fully expanded. A foliage check is secured, but further growth occurs later.

Willows with smooth green bark at the base of the bole such as young trees of crack and weeping willows and pussy willows at all stages of growth are controlled most effectively by a basal application of a mixture of 2,4-D oil-soluble ester and diesel fuel oil to an area twice the diameter of the tree from ground level upward. A suitable concentration is 1lb. of acid equivalent of 2,4-D oil-soluble ester in 10 to 20 gallons of diesel fuel oil. From 2 to 3 fl.oz. should be applied to a tree 2in. to 3in. in diameter. Care should be taken to ring the tree completely on green bark, as poor control results if when spraying is done dead wood on part of the bole is treated. Once the trees have developed thick corky bark the hormone-diesel fuel oil mixture fails to penetrate and control is not secured. The method to be employed for such trees is described here.

Willows with mature corky bark at the base of the bole as in the case of crack or weeping willows: For securing entry of the hormone into this type of tree the thick corky bark must first be removed. This operation of frilling has been executed successfully by winding a plastic detonating fuse containing an explosive charge round the tree 1ft. to 3ft. from the ground and detonating it. The underlying wood is exposed but not damaged and the bark is pulverised into spongy tissue which



A frill made on willow tree with Cordtex. A solution of 2,4-D and diesel fuel was applied to the frill. The trees are now dead.

readily absorbs the hormone-diesel fuel oil mixture. If an axe is used, care should be taken not to damage the underlying wood; the cut must be V-shaped and horizontal to hold the

weedkilling preparation. With an axe difficulty is experienced in frilling leaning trees. In all cases the frill must encircle the tree completely and must be on green wood. A preparation



An area of willows killed by basal frilling with Cordtex plus solution of 2,4-D and diesel fuel applied to the frill.

of 1lb. of acid equivalent of an oil-soluble ester of 2,4-D in 5 gallons of diesel fuel oil is suitable.

Alternative methods of control are the over-all spraying of trees and the stump method. The first is costly and great care is needed to secure the over-all foliage cover. The concentration is that used for suckers and seedlings, but a larger quantity of material per acre is required. In the stump method an oil-soluble ester of 2,4-D of 1lb. of acid equivalent in 10 to 20 gallons of diesel fuel oil is applied to the freshly cut surface and the sides of the stump. Where possible the plants should be cut off close to the ground; if that is not possible for mature trees, the bark should be stripped back. Individual suckers should also be treated.

Factors Affecting Control

Factors that affect the efficiency of control of willows with 2,4-D are as follows:—

Times and rates of application: The best results from over-all spraying of willows are obtained in summer. Spring spraying results in further shooting and recovery. Bole applications and stump treatments may be carried out at any time, though possibly applications in the dormant season are best. Trees treated in the dormant season burst into leaf as normally but die later; death results after 6 to 12 months. As for most weed species the rates of application may be reduced in northern districts for the over-all spray methods.

Cover or spray distribution: Complete spray cover is very important, and if this is not obtained and there is not a complete kill, a follow-up spray is necessary 2 months after the initial application, when areas missed can be dealt with effectively. In bole applications the hormone-diesel fuel oil mixture must be applied equally round the tree on living wood or bark.

Carrier or spreader for 2,4-D: Water is used in over-all spraying and aromatic oils such as diesel fuel oil or kerosene in bole and stump applications. As in the treatment of gorse and blackberry the incorporation of an aromatic oil in the mix for over-all spraying would result in leaf burn or

scorch with subsequent recovery. In the bole and stump applications the diesel fuel oil serves as both carrier and penetrant. Further trial work may show the possibility of a concentrated hormone-diesel fuel oil mixture being effective when applied equally over the trees in the dormant season.

Formulations: Little difference has been detected in the efficiency of 2,4-D oil-soluble esters and similar 2,4,5-T preparations; 2,4-D is probably slightly more toxic. Better results have been obtained with volatile preparations of 2,4-D in over-all spray treatments owing probably to a better cover. For bole and stump applications low-volatile and volatile oil-soluble esters give the same results. The question of penetrants is important, and further trial work may discover some that will penetrate the bark without the need for frilling.

Willow Herb

(*Epilobium* spp.)

Seedlings of willow herb (*Epilobium* spp.) are killed by esters of 2,4-D at 1lb., older plants are controlled by esters of 2,4-D at 1lb., and established perennial plants require more than one application for complete kills.

Winged Thistle

(*Carduus tenuiflorus*)

An annual to biennial plant quite common in waste places and open pastures throughout New Zealand, winged thistle (*Carduus tenuiflorus*) is very susceptible as seedlings and is killed by 0.5lb. to 1lb. of the salts and amines of M.C.P. and 2,4-D. Mature plants require slightly higher rates for control, but in all cases the application should be made while the plants are growing vigorously and before the onset of dry weather. If extremely dry conditions have prevailed before the application and the plants are past the maximum rosette stage, up to 3lb. is required. This thistle is successfully treated from the air by solutions of 2,4-D and diesel fuel oil under good growing conditions. It can also be treated successfully by the aerial application of hormonised fertilisers, particularly if the surface of

the leaf is moist at the time of application and rain does not fall for 3 to 4 days after the application.

Trials have shown that oversowing and topdressing must follow the spraying of winged thistle; otherwise the area is soon reinfested. In trials two applications a year have been required to keep winged thistle under control where oversowing and topdressing have not been done.

Wireweed

(*Polygonum aviculare*)

Wireweed (*Polygonum aviculare*) occurs in cultivated land throughout New Zealand. A difficult annual to kill, it is checked as seedlings by the amines of 2,4-D or polyethylene glycol ester of 2,4-D at 1lb. to 2lb. It shows too much tolerance to be controlled successfully in crops such as linseed and potatoes. The above chemicals check it sufficiently in wheat and barley to allow a clean harvest.

It is killed at the seedling stage of growth by salts of phenols at 1lb. to 2lb. and aromatic oils. Pre-emergence applications of hormones at 2lb. to 4lb., phenols at 2lb. to 4lb., urea compounds at 2½lb. to 5lb., T.C.A. at 15lb. to 30lb., and C.I.P.C. at 3lb. to 5lb. are satisfactory. Oktone at 4lb. plus diesel fuel oil has given good results.

Wood Sage

(*Teucrium scorodonia*)

For wood sage (*Teucrium scorodonia*), a perennial occurring in isolated localities in both Islands, the best control is obtained with esters of 2,4-D at rates up to 3lb. applied when the plants are coming into flower in autumn. Esters of 2,4,5-T are slightly less effective than esters of 2,4-D and poorer control is obtained with salts and amines of M.C.P. and 2,4-D. A

repeat treatment the following autumn is necessary for complete control.

Yarrow

(*Achillea millefolium*)

Frequent to locally abundant in waste places, playing greens, and dry pastures throughout New Zealand, yarrow (*Achillea millefolium*) is a perennial with creeping root stocks requiring more than one application for its destruction. The first application should be made at flower-head initiation with esters of 2,4-D at 1lb. to 2lb. followed by repeat treatments when the regrowths are fully developed.

Yellow Gromwell

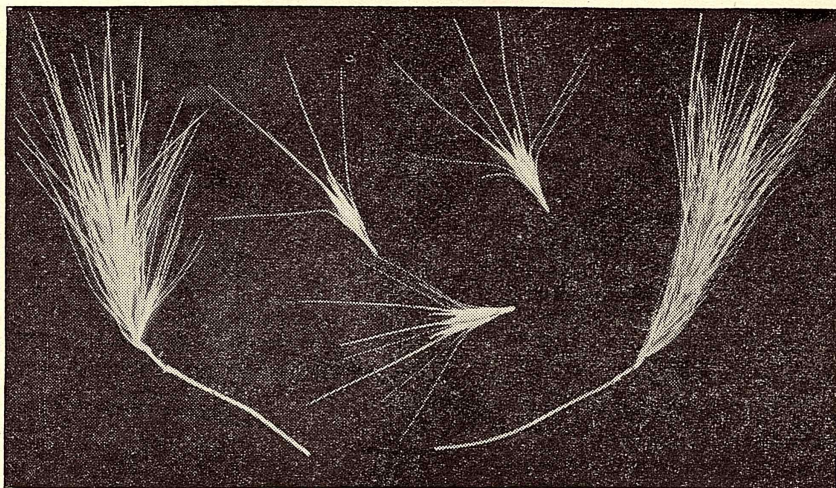
(*Amsinckia angustifolia*)

An annual restricted at first to Central Otago, but more recently spreading into cereal crops from Ashburton southwards, yellow gromwell (*Amsinckia angustifolia*) is an annual doubtfully checked by salts and amines of M.C.P. and 2,4-D, but checked or killed by esters of 2,4-D at 1lb. from seedlings to early establishment stages. Its control in crops is restricted to barley and wheat, as it shows too much tolerance to be controlled in crops such as potatoes and linseed.

Yellow Weed

(*Galinsoga parviflora*)

An annual restricted to several localities in the North Island, yellow weed (*Galinsoga parviflora*) occurs both in cultivated land and waste places. It is checked or killed as seedlings by salts and amines of M.C.P. and 2,4-D at 1lb. and shows susceptibility up to flower-head formation to esters of 2,4-D at 1lb. to 2lb.



Close-up of seed heads and individual barbs of barley grass that cause damage to sheep.

GRASSES

In the following list T.C.A. is the chemical most widely recommended, but further work is required with more recently developed chemicals such as Dalapon.

Barley Grass

(*Hordeum murinum*)

An annual growing in high fertility areas in both Islands, and where the sward is open, barley grass (*Hordeum murinum*) is undoubtedly increasing in prevalence as the fertility is raised. It may be selectively controlled by applications of T.C.A. up to 10lb. or 15lb. or C.I.P.C. or I.P.C. at rates up to 4lb. to 6lb. applied to germinating seedlings. The best method of control is to map out the areas when the barley grass is in seed head and readily distinguished. If T.C.A. is to be employed, the area should be oversown with clover and fertilised and the T.C.A. applied immediately. This should be done after the autumn rains have set in; May has given very satisfactory results. The T.C.A. applied at 10lb. to 15lb. controls the germinating seed of barley grass, but does not seriously affect the germination of the clover. The same method may be adapted for I.P.C. and C.I.P.C., but these chemicals inhibit the growth of grasses for 1 to 2 months and the area becomes largely

clover dominant. A repeat application is probably necessary the following spring to kill spring germinating plants in open areas. C.M.U. has given satisfactory control of germinating seedlings in lucerne crops at rates over 2lb.

Dalapon at 1lb. to 2lb. is very promising. It should be applied to germinating seedlings.

Barnyard Grass

(*Echinochloa crusgalli*)

Barnyard grass (*Echinochloa crusgalli*) is an annual grass locally common in waste places and cultivated areas in the northern half of the South Island northwards. It is controlled by pre-emergence applications of T.C.A. at 10lb. to 15lb. and I.P.C. and C.I.P.C. at 2lb. to 4lb.

Browntop

(*Agrostis tenuis*)

Browntop (*Agrostis tenuis*) is a perennial plant widely used in low fertility pastures and playing greens. It is most troublesome in lucerne stands and established perennial crops such as asparagus and small fruits. Browntop shows a wide range of tolerance to T.C.A. Under acid turf conditions it has been killed at rates of 10lb. to 20lb. In lucerne areas rates of 20lb. to 40lb. are required. With prior cultivation excellent control has

been obtained with rates of 15lb. to 25lb. In all cases follow-up treatments should be made if complete eradication is desired. Browntop seedlings are killed by 5lb. to 15lb. of T.C.A. or 2lb. of I.P.C. or 2lb. to 4lb. of C.I.P.C. or C.M.U. at rates over 2lb. In waste areas it has been killed by rates of C.M.U. of 20lb. to 40lb., of "Atlacide" and "Polyborchlorate" at rates over 500lb., and Borascu at rates over 1000lb.

Cocksfoot

(*Dactylis glomerata*)

Only successfully controlled as seedlings by T.C.A. at rates of 15lb. to 20lb. or I.P.C. and C.I.P.C. at germination at rates of 2lb. to 4lb. Mature plants normally require rates over 100lb. of T.C.A. for control. Initial work with Dalapon is promising at rates of 30lb. to 40lb. for established plants. In waste areas it is killed by C.M.U. at rates over 60lb. and by "Atlacide" and "Polyborchlorate" at 600lb., and Borascu at rates over 1000lb.

Chewings Fescue

(*Festuca rubra* var. *fallax*)

Chewings fescue (*Festuca rubra* var. *fallax*) is a perennial plant forming sodbound mats, which is effectively killed by C.M.U. at rates over 40lb., by "Atlacide" and "Polyborchlorate" at rates over 500lb., and Borascu at rates over 1000lb. No work has been carried out on its selective control.

Crab Grass

(*Digitaria sanguinalis*)

An annual crab grass (*Digitaria sanguinalis*) is locally common in waste places and cultivated land in both Islands. Germinating seedlings are killed by 10lb. to 15lb. T.C.A., I.P.C. at 1lb. to 2lb., and C.I.P.C. at 1lb. to 3lb. Established plants require rates of T.C.A. as high as 40lb. to 60lb. It has been killed by Dalapon at 20lb. and 30lb. as established plants, by C.M.U. in waste areas at rates over 40lb., and by "Atlacide" and "Polyborchlorate" at rates over 500lb., and Borascu at rates over 1000lb.

Creeping Bent

(*Agrostis stolonifera*)

A stoloniferous perennial, creeping bent (*Agrostis stolonifera*) shows

tolerance similar to browntop. It is best controlled by T.C.A. in conjunction with cultivation and cropping. Resistant crops should be treated at pre-emergence with up to 20lb. T.C.A. A follow-up treatment of T.C.A. or cultivation after the crop is removed should be made to destroy regrowths. Without prior cultivation rates of 30lb. to 40lb. are required and repeat applications are necessary. In waste areas it has been killed by C.M.U. at rates over 40lb.

Creeping Fog

(*Holcus mollis*)

A perennial with creeping rootstocks creeping fog (*Holcus mollis*) is found in cultivated areas in both Islands. It is susceptible enough to applications of T.C.A. to be destroyed in crops in conjunction with cultivation. Cultivation should include discing or rotary hoeing to break up the underground rhizomes. Resistant crops infested with creeping fog should be treated at pre-emergence with up to 20lb. T.C.A. A follow-up treatment should be made either as a repeat dressing of T.C.A. or as cultivation for the control of regrowths.

Floating Sweet Grass

(*Glyceria fluitans*)

Frequently to locally plentiful in damp pastures and shallow pools in both Islands, floating sweet grass (*Glyceria fluitans*) has been killed by T.C.A. at 40lb. and by C.M.U. at 30lb. on the edges of water. A repeat application of T.C.A. is sometimes necessary. Dalapon shows promise at 20lb. to 40lb.

Hairgrass

(*Vulpia dertonensis*)

Hairgrass (*Vulpia dertonensis*) and English hairgrass (*Aira* spp.) are abundant in waste places and light open pastures throughout New Zealand. In pastures control should be by raising fertility. In waste areas it is readily killed by T.C.A. at 20lb. to 30lb. or Dalapon at 10lb. to 20lb. In waste areas it has been killed by rates of C.M.U. over 20lb.

Kangaroo Grass

(*Themeda triandra*)

Kangaroo grass (*Themeda triandra*) is a perennial occurring in several localities in the North Island and in Marlborough. Control with T.C.A. is not very successful. Initial application should be 100lb. followed by repeat treatment of 25lb. when regrowths develop. Applications of 200lb. have virtually given complete control. Further work is required with Dalapon. If a successful chemical is available, steps should be taken to eradicate this weed grass.

Kentucky Bluegrass

(*Poa pratensis*)

Plentiful in both Islands Kentucky bluegrass (*Poa pratensis*) is a cause of concern in lucerne and annual crops. A rhizomatous perennial it is selectively killed as seedlings by T.C.A. up to 10lb., or I.P.C. or C.I.P.C. at 1lb. to 3lb. If established, it is best controlled by cultivation and the treating of a resistant crop at pre-emergence by up to 20lb. of T.C.A. Discing or rotary hoeing should be included in the cultivation practices and a follow-up treatment either of T.C.A. or cultivation should be made to destroy regrowths following the initial application. In lucerne it can be kept in check by 30lb. to 40lb. of T.C.A. applied in the dormant season. Again a follow-up treatment is necessary to control regrowths.

Kikuyu

(*Pennisetum clandestinum*)

Kikuyu (*Pennisetum clandestinum*) is a stoloniferous perennial satisfactorily killed by T.C.A. In waste areas or for spot treatments in pastures the initial application should be 50lb. to 70lb., preferably applied in autumn. Isolated regrowths should be treated the following spring. In pastures the best control is obtained by cultivation prior to applying the T.C.A. Rates of 40lb. to 50lb. are required with a spot treatment the following spring. In both cases the area should be oversown 6 weeks to 2 months later to reclothe the area in desirable vegetation. Sodium chlorate at rates up to 5cwt.

has been successful, but as this material is non-selective, clovers and other desirable species have been eliminated for several months. Further work is required with Dalapon for selective control. In waste areas it has been satisfactorily controlled by C.M.U. at rates over 60lb.

Indian Doub

(*Cynodon dactylon*)

Indian doub (*Cynodon dactylon*) is common to locally abundant in waste places and dry light land pastures in the North Island and northern part of the South Island. A perennial with creeping rhizomes it is most effectively destroyed with T.C.A. in conjunction with cultivation. Resistant crops should be treated at pre-emergence with 20lb. of T.C.A. A follow-up treatment should be made following the crop either as a further treatment of T.C.A. or by cultivation to destroy any regrowths. Without prior cultivation 40lb. to 60lb. T.C.A. is required preferably in the autumn with a follow-up treatment the following spring. In waste areas it has been killed by C.M.U. at rates over 40lb.

Manchurian Wild Rice

(*Zizania latifolia*)

Manchurian wild rice (*Zizania latifolia*) is localised to the low lying land and water channels in the vicinity of the Northern Wairoa River. There is no satisfactory method of control to date. Extremely high rates of T.C.A. sprayed on to young regrowths after burning or cutting have given some control on the drier margins. Further work is required with newer chemicals such as Dalapon.

Nassella Tussock

(*Nassella trichotoma*)

Nassella tussock (*Nassella trichotoma*) is fairly readily killed as seedlings by T.C.A. up to 25lb. Mature plants require up to 100lb. for control. The time of application appears important. The best results are probably obtained in December, January, February, and March. Nassella is probably growing most vigorously at this period. Poor results have been obtained on

higher fertility soils where applications have been made in late autumn or winter. More work is required on times of application on various soil types and with newer chemicals such as Dalapon. Even at high rates of application C.M.U. has not been successful, possibly because there has been insufficient rainfall for activation of the C.M.U.

Nigger Head

(*Mariscus ustulatus*)

A perennial occurring in the North Island and largely confined to the coastal areas in the South Island, nigger head (*Mariscus ustulatus*) is controlled with T.C.A. only at high rates of application. Further work is required. Control is probably best obtained by pasture improvement, as this weed cannot survive in competition with high fertility pastures.

Onion-rooted Twitch

(*Arrhenatherum elatius* var. *bulbosum*)

Established in cultivated land in Canterbury, onion-rooted twitch (*Arrhenatherum elatius* var. *bulbosum*) is a perennial with small corms at the bases of the culms (flowering stalks). Control is satisfactory with T.C.A., particularly in conjunction with cultivation. The area should be treated with 30lb. to 40lb. of T.C.A. and a crop sown about a month later. After the crop the regrowths should be controlled either by cultivation or a repeat application of T.C.A. Further work is required with Dalapon.

Paspalum dilatatum

Paspalum dilatatum is plentiful in the northern half of the North Island and less common in the northern part of the South Island. It is killed as seedlings by 20lb. to 30lb. of T.C.A., but mature plants are relatively resistant to T.C.A. Rates of 60lb. to 80lb. of C.M.U. are required to kill established plants. Further work is required, particularly with Dalapon.

Paspalum distichum

A perennial with stout rhizomes, *Paspalum distichum* is confined to

several localities in the North Island. In conjunction with cultivation, rates of 30lb. to 40lb. T.C.A. have given good control. A follow-up treatment to destroy surviving regrowths is essential; otherwise the area is quickly reinfested. Destruction of the weed should preferably be done in conjunction with a cropping programme. The area should be cultivated, treated with 30lb. to 40lb. of T.C.A., and sown to a crop a month later or after heavy rain. Regrowths should be treated after the crop.

Pennisetum macrourum

A tall-growing rhizomatous plant, *Pennisetum macrourum* is probably confined to localised patches, the largest of which is near Kaikoura. It is possibly susceptible to high rates of application of T.C.A., repeat treatments being required. Further work needs to be done with C.M.U. and Dalapon.

Poa annua

Poa annua is an annual grass plentiful throughout New Zealand. In crops it is readily killed as germinating seedlings by T.C.A. at 5lb. to 10lb., I.P.C. at 1lb. to 2lb., and C.I.P.C. at 2lb. to 3lb. or P.M.U. and C.M.U. at rates over 1lb. Seedlings 1in. to 2in. high are checked or killed by D.N.B.P. at 2lb. This weed shows sufficient susceptibility to T.C.A. and the carbamates to be weeded out of established fibrous rooted grasses. High rates of Endothal, 4lb. to 8lb., are satisfactory in dormant crops such as lucerne and asparagus.

Prairie Grass

(*Bromus catharticus*)

Prairie grass (*Bromus catharticus*) is a short-lived perennial grass plentiful in waste places throughout New Zealand. It is utilised as a pasture species. It is killed in the establishment stages by T.C.A. at 20lb. to 30lb., but as it occurs largely as a weed in waste places, soil sterilants are the best chemicals for its control. Rates of 40lb. of C.M.U. are required to kill established plants. "Atlacide" at 300lb. to 500lb. or "Polyborchlorate" at 600lb. and Borascu at 1000lb. have been satisfactory.

Purua "Grass"*(Scirpus maritimus)*

Purua "grass" (*Scirpus maritimus*) is a perennial plant confined to brackish water areas from the North Cape to Otago. The only satisfactory control obtained to date has been with high rates of C.M.U. at 60lb. to 80lb. Other soil sterilants such as Borascu, "Polyborchlorate", and "Atlacide" at rates of 1000lb. have given poor results. T.C.A. at 250lb. has also been poor.

Ratstail*(Sporobolus capensis)*

A fibrous-rooted perennial, ratstail (*Sporobolus capensis*) is not uncommon in the northern half of the North Island, but occurs southwards to the northern parts of the South Island. Selective control in pastures is not possible, but soil sterilants secure satisfactory control in waste areas. C.M.U. at rates of 40lb. and over has given the most satisfactory control. Other materials such as "Atlacide" and "Polyborchlorate" are required at rates over 600lb. and Borascu at rates over 1000lb.

Reed Sweet Grass*(Glyceria maxima)*

Reed sweet grass (*Glyceria maxima*) is a perennial plant occurring in wet places in both Islands. It has been killed by high rates of chlorinated hydrocarbons (dilutions of 1:250). High rates of "Atlacide", 1000lb. to 1500lb., have been satisfactory on dry land. Much further work is required with newer chemicals such as C.M.U. and Dalapon.

Rough-stalked Meadow Grass*(Poa trivialis)*

Rough-stalked meadow grass (*Poa trivialis*) is a perennial that establishes by stolons. In waste places it is killed by rates of 40lb. C.M.U. and rates of "Atlacide" and "Polyborchlorate" at 500lb. to 700lb., and Borascu at rates over 1000lb. In conjunction with cultivation it is killed by rates of T.C.A. at 20lb. to 30lb.

Ryegrass*(Lolium spp.)*

Perennial ryegrass (*Lolium perenne*), Italian ryegrass (*L. multiflorum*), and

short-rotation ryegrass (*L. hybrid* spp.) are effectively killed by T.C.A. at rates of 20lb. to 30lb. only in the early establishment stages. Mature plants require rates of 50lb. to 60lb. for control. Germinating seedlings are killed by I.P.C. at 1lb. to 3lb. and C.I.P.C. at 2lb. to 4lb. and by C.M.U. at rates over 2lb. and T.C.A. at 10lb. to 15lb. Further work is required with Dalapon for selective control of established plants. In waste areas good control has been obtained with C.M.U. at 40lb., "Atlacide" and "Polyborchlorate" at rates over 400lb. to 600lb., and Borascu at rates over 1000lb.

Sedges*(Carex spp.)*

Rhizomatous sedge species such as *Carex ternaria* are possibly susceptible to high rates of T.C.A., 40lb. to 60lb., in conjunction with cultivation. Discing should be included in the cultivation programme. The T.C.A. should be applied and a resistant crop sown about a month later. A repeat application should be made after the crop. Fibrous rooted species such as *Carex lucida* show too much tolerance to be controlled by selective applications of T.C.A., as rates of 150lb. to 200lb. are required. Further work is required with Dalapon and the possibility of developing hormone preparations for control. In waste areas promising results have been obtained with C.M.U. at rates of 60lb. to 70lb.

Sweet Vernal*(Anthoxanthum odoratum)*

Sweet vernal (*Anthoxanthum odoratum*) is a tufted perennial abundant in waste places and poor pastures throughout New Zealand. Germinating seedlings are killed by pre-emergence applications of T.C.A. at 5lb. to 10lb., I.P.C. at 1lb. to 2lb., and C.I.P.C. at 1lb. to 2lb., or by P.M.U. and C.M.U. at rates over 2lb. Establishing plants are killed by rates of T.C.A. at 20lb. to 25lb. and by Dalapon at rates of 10lb. to 15lb. Mature plants are killed by rates of T.C.A. over 40lb. and by Dalapon at rates over 20lb. It is effectively killed by C.M.U. at rates over 30lb. and "Atlacide", Borascu, and "Polyborchlorate" at rates over 400lb. to 600lb. in waste places.

Tall Fescue*(Festuca arundinacea)*

Tall fescue (*Festuca arundinacea*) is fairly abundant in dairy pastures and waste places throughout New Zealand. It is a fibrous rooted perennial showing high resistance to T.C.A., particularly on peaty soils. Rates up to 200lb. are required. It is effectively killed as germinating seedlings by T.C.A. at 10lb. to 15lb. and as established plants by rates of 30lb. to 40lb. Further work is required with Dalapon. Soil sterilants, particularly C.M.U. at rates over 60lb., have given excellent control.

Timothy*(Phleum pratense)*

A perennial common in pastures and waste places in both Islands, timothy (*Phleum pratense*) is killed as germinating seedlings by T.C.A. at 5lb. to 10lb., I.P.C. at 1lb. to 2lb., or C.I.P.C. at 1lb. to 3lb., and by C.M.U. at 2lb. to 5lb. It is controlled in the early establishment stages by T.C.A. at 15lb. to 20lb. Mature plants require 40lb. to 60lb. for control. In waste places good control is obtained by C.M.U. at rates over 40lb., and by "Atlacide" and "Polyborchlorate" at rates of 400lb. to 600lb. and Borascu at rates over 600lb.

Toad Rush*(Juncus bufonius)*

An annual, toad rush (*Juncus bufonius*) is locally abundant in waste places and on cultivated land throughout New Zealand. Germinating seedlings are killed by T.C.A. at 10lb. to 20lb. and by I.P.C. at 2lb. to 4lb., and C.I.P.C. at 4lb. to 6lb. C.M.U. is effective at 2lb. to 5lb. Mature plants are effectively killed in waste areas by C.M.U. at rates of over 20lb., and "Atlacide" and "Polyborchlorate" at

rates over 300lb. to 400lb. and Borascu at rates of 800lb.

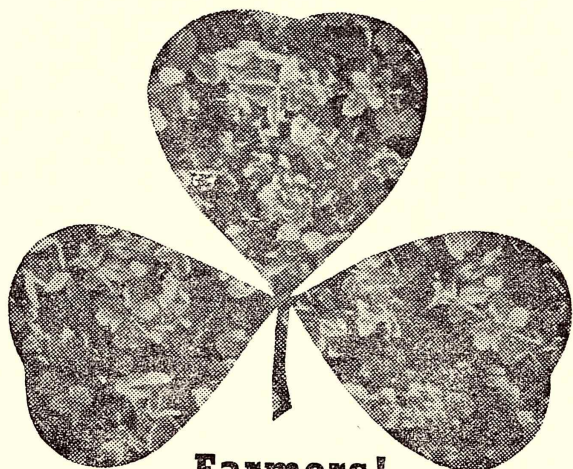
Twitch*(Agropyron repens)*

"Old-man" twitch, twitch, or couch (*Agropyron repens*) occurs in cultivated land, dry pastures, and waste places throughout New Zealand. A perennial with creeping rhizomes, it is readily controlled by T.C.A., particularly in conjunction with cultivation. Cultivation should include either rotary hoeing or discing. A resistant crop should be treated at pre-emergence by 20lb. of T.C.A. or sown a month after a treatment of 25lb. to 30lb. if the infestation is really thick. Regrowths should be destroyed after the removal of the crop either by further applications of T.C.A. or cultivation. If the regrowths are not controlled, the area is quickly reinfested. If the area cannot be cultivated prior to application of the T.C.A., an initial dressing of 40lb. to 50lb. should be made, followed by a repeat dressing to kill surviving regrowths. C.M.U. in waste areas has given good control at rates of 60lb. Further work is required with Dalapon, particularly for waste areas and orchards.

Yorkshire Fog*(Holcus lanatus)*

Yorkshire fog (*Holcus lanatus*), a perennial, occurs in pastures and waste places throughout New Zealand. Established plants are killed by T.C.A. at 40lb. to 60lb. Dalapon in initial work, is effective at 20lb. to 30lb. It is effectively destroyed by soil sterilants; C.M.U. at rates over 20lb., "Atlacide" and "Polyborchlorate" at rates of over 400lb., and Borascu at rates over 1000lb.

As germinating seedlings in crops it is killed by T.C.A. at 10lb. to 15lb. and by I.P.C. and C.I.P.C. at 2lb. to 4lb., and urea compounds at rates over 2lb.



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SECTION 3 — WEED CONTROL IN SPECIFIC AREAS

Recommendations given in this section are based on work done in New Zealand. Where no work has been done in New Zealand mention will be made of this fact and the result of overseas work given. Reference should be made to the section on chemicals for the detail on the use of preparations mentioned. The general principle in crop spraying is to treat the weeds as early as the crop will permit in the case of germinating annuals and perennials. For perennials that rise from suckers the weeds should be treated as near to the maximum leaf development as the crop will permit.

Wheat, Barley, and Oats

Wheat and barley may be considered together, as they show similar tolerance to hormone weedkillers. Oats are far more susceptible. There are two distinct stages of growth at which wheat and barley may be damaged by hormone preparations. The first stage is prior to the 6 true leaf stage. The number of leaves are determined by counting the leaves on the main tiller and adding one leaf for each secondary tiller. The second stage is in the ear stage (boot stage), that is, when the upper sheath is beginning to swell with an enlarging head to the stage when it is fully headed. At stages other than these wheat may be sprayed without damage.

If the weeds rise largely from germinating annuals and perennials, spraying should be done as near to the 6 true leaf stage as possible. If the stand is largely of weeds that rise from root regrowths such as Californian thistle, the spraying should be done when the wheat is approaching the ear stage.

Trial work has shown that the most suitable preparations for control of weeds in wheat are the water-soluble preparations of M.C.P. applied at rates up to 1lb. or heavier if the weeds are dense. These preparations cause the least damage to wheat and barley if the spraying is applied at the susceptible periods. If this is done, more damage results from the later times of application than at the stage prior to the 6 true leaf stage. Esters of 2,4-D are more severe than the water-soluble preparations of 2,4-D.

Water-soluble salts and amines of M.C.P. will control most of the susceptible weeds such as wild turnip,

Californian thistle, etc., but usually are not effective against cornbind, gromwell, etc. If these weeds are predominant, then the polyethylene glycol ester of 2,4-D should be employed at rates not higher than 1lb. per acre. The amine salts of 2,4-D are slightly less effective at rates up to 1.5lb.

Most of the weeds that show resistance to hormone preparations and in particular water-soluble preparations of M.C.P. are effectively controlled by pre-emergence applications of T.C.A. in brassica or potato crops. The rate of application should be 10lb. to 20lb. Weeds such as wireweed, cornbind, wild oats, and other germinating grasses are controlled. A satisfactory rotation would be to sow a brassica crop such as chou moellier in late spring, apply the T.C.A. immediately the crop is sown, and sow the cereal crop the following autumn. In this way effective weed control is obtained without summer fallowing.

Oats differ from wheat and barley in that they appear to be resistant from the first true leaf to the start of shooting. The other stages appear to be the same as for wheat and barley. As oats are more sensitive than barley and wheat, only preparations of salts and amines based on the 2, 4 isomer of M.C.P. should be used at rates up to 1lb.

Ryecorn

Little work has been done in New Zealand, but it appears to be safe to spray ryecorn with salts and amines of M.C.P. at rates up to 1lb. at the same stages as wheat and barley.

Maize (Not Including Sweet Maize)

Maize (not including sweet maize) may be treated at pre-emergence or at post-emergence. Chemicals suitable for pre-emergence applications are preparations of 2,4-D (preferably the esters) on loam soils and soils high in organic content. Light, sandy soils are not suitable, as excessive leaching may take place. Better weed control normally results from the use of M.C.P. and 2,4,5-T preparations, but there is a greater chance of maize damage with these preparations. Rates of application are 2lb. to 4lb. Phenols are safe on all soil types at rates up to 4lb. Oktone at 4lb. plus diesel fuel oil is safe on all soil types and for all

maize varieties. Other chemicals, such as Natrin, S.E.S., Sesin, etc., are also suitable at rates up to 6lb. on the same soil types as 2,4-D preparations.

At the post-emergence stage maize is tolerant to M.C.P. water-soluble preparations from emergence to tasseling. Maize should not be sprayed for 2 to 3 weeks before the silking stage. Maize is more tolerant to M.C.P. than 2,4-D, but rates above 1lb. should not be employed and in all cases the spray should be directed as much as possible below the foliage of the maize, but sufficiently high to contact the tops of the weeds. Environmental factors are more important in causing maize damage than the morphological growth stage between emergence and tasseling. Hormone damage usually results in brittleness of stalks and subsequent damage by wind may be severe.

Potatoes

In the past potatoes were regarded as a "cleaning" crop, but today wheat and barley can be regarded similarly. Potatoes do not usually require to be chemically weeded, but in some instances chemical weed control is necessary; for example, wet seasons. In areas where the rainfall is above 20in. potatoes tolerate up to 30lb. of T.C.A. as a pre-emergence application. With prior cultivation, which should include discing or rotary hoeing, most couch or twitch-like grasses are susceptible to rates up to 30lb. of T.C.A. Subsequent cultivation of the crop is usually sufficient to eradicate twitch-like grasses without the necessity of summer fallowing; hence potatoes can be used as a cleaning crop for areas of twitches, germinating grasses, and some species of broad-leaved weeds such as red root, cornbind, etc.

Hormone weedkillers, phenols, etc., may be also used as pre-emergence treatments. The water-soluble preparations of M.C.P. at rates up to 1lb. may be used from emergence up to the 6in. stage. Several days' fine weather should preferably precede the spraying to toughen the potato leaves. In all trial work conducted to date 2,4-D preparations have been too severe on potatoes, resulting in a reduction in yield.

The evidence from trials suggests that if all potato varieties were treated

at the same stage of growth, for example, just prior to flowering, then the shorter-growing varieties such as Katahdin and Chippewa are more tolerant than taller-growing varieties such as Dakota, Aucklander Tall Top, etc. However, if all varieties are treated at the 0 to 6in. stage, then there is little difference in varietal response.

Perhaps the greatest use of weed-killing chemicals for potatoes is as crop desiccants. Chemicals may be used to arrest late blight and to facilitate mechanical harvesting by killing the top growth of the potatoes and any weeds present. There are a number of chemicals suitable for this purpose.

Sulphuric acid is an excellent desiccant, but has distinct disadvantages. Arsenical preparations fall in the same category. Recommended materials are parent phenols fortified with aromatic oil or creosote and applied in water, Oktone at 1lb. to 20 gallons of aromatic oil, Endothal 4069 at rates up to 8lb., and "Atlacide" at rates up to 30lb. per acre. "Atlacide" at these rates is not effective against grasses. With the quick-acting materials such as the parent phenols, Oktone and Endothal, a scorch of the vegetation is evident in 2 to 5 days. The parent phenols should be applied under hot weather conditions and rain should not fall for 3 to 4 days after the application of all treatments. For the successful application of these materials a complete foliage coverage is required and sufficient water should be employed to wet the potatoes and weeds thoroughly.

Peas

At the moment peas are successfully weeded with post-emergence applications of D.N.B.P. preparations—usually formulated as ammonium salt. Peas are normally sprayed when 4in. to 6in. high, but for successful control of weeds they should be sprayed as near to the seedling stage as possible. The rates of application depend on the weather conditions and will vary from 1lb. to 2lb. per acre. Care should be taken to see that no overlapping of spraying occurs.

Sufficient water should be employed to secure a complete foliage cover of the weeds without causing atomisation of the spraying material, as this

will damage the peas. To increase the resistance of the peas, several days of fine weather should precede the application and the crop should be dry at the time of application. Early picking varieties of peas appear more susceptible to damage than later cropping varieties.

Further work is being conducted with hormone preparations to determine if these preparations are suitable. From initial work with salts and amine preparations of M.C.P. based on the 2,4 isomer no apparent yield reduction occurs with rates up to 0.75lb. per acre. The polyethylene glycol ester of 4-C has also been very promising at rates up to 1lb. Further, the development of M.C.P.B. and 2,4-DB adds greater promise for the successful control of weeds in peas.

To avoid wheel damage to the crop pre-emergence treatments with parent phenols at rates of 4lb. to 8lb. as soon as the peas are sown have been used successfully. I.P.C. at rates up to 4lb. and T.C.A. at rates up to 10lb. to 15lb. can be used as pre-emergence treatments if grass weeds are particularly severe. C.I.P.C. may also be employed at rates up to 4lb. for general weed control as a pre-emergence treatment.

Crop desiccants are of value for pre-harvest weed control for drying up the crop before harvesting. The most suitable preparations are the parent phenols fortified with aromatic oils or creosote applied at 4lb. to 8lb., or Endothal 4069 at rates up to 8lb. The application should be made 4 to 5 days before crop harvest.

Brassicas

For convenience brassicas have been divided into farm crops: swedes, turnips, chou moellier, rape, and kale; and into garden crops: brussels sprouts, cauliflower, cabbage, broccoli, curly kale, etc.

Weed problems in swedes and turnips are usually more serious than in chou moellier, rape, and kale. T.C.A. applied as a pre-emergence treatment immediately the crop is sown under the appropriate moisture conditions has given excellent weed control at rates up to 20lb. for swedes and turnips and rates up to 15lb. for chou moellier, rape, and kale.

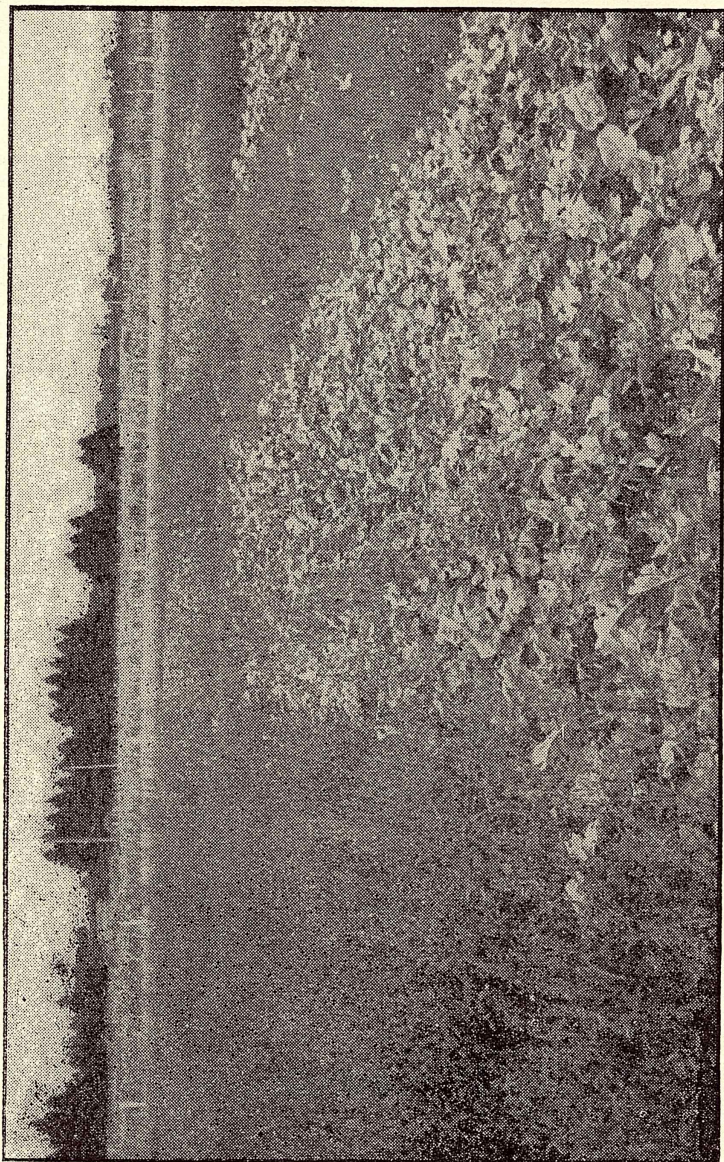
Oktonone at rates up to 4lb. plus the appropriate aromatic oil (diesel fuel oil for warm conditions and kerosene for cool soils) has also been very satisfactory. If soil conditions are dry and germination of the crop is slow, an application made from 3 to 4 days after the crop is sown is satisfactory; under moist conditions a pre-emergence method should preferably be employed, that is, the brassica seed is drilled into an area where the weeds have germinated and the Oktonone is applied no later than 3 days after the sowing. In all cases, if diesel fuel oil is employed at more than 10 to 15 gallons per acre, the area should be sprayed at least 2 days before crop emergence. The successful use of this chemical depends to a great extent on local knowledge, but it has the distinct advantage of not being dependent on weather conditions, as it works satisfactorily under dry or wet conditions.

The above chemicals may be used for weed control in garden brassicas both as pre-emergence treatments or as directed post-emergence applications, so that the spray material does not fall on the crop that has been lined out.

Overseas: Nix has been used as a directed spray at rates up to 8lb. per acre, as frequently as required.

Lucerne

The development of the urea compounds has opened new possibilities of keeping lucerne weed-free fairly readily. Established lucerne tolerates low rates of C.M.U. of 1lb. to 4lb. These rates will keep out most germinating annuals and perennials. The lucerne area should be freed of all perennials establishing from root regrowths and the area kept free of weeds until the lucerne is established. This may be done by pre-emergence applications of I.P.C. and C.I.P.C. at rates up to 4lb., and by post-emergence applications of D.N.B.P. after the lucerne has passed the 2 to 3 true leaf stage. Parent phenols may be employed in diesel fuel oil in the dormant season. T.C.A. can be used at rates up to 40lb. in the dormant season without greatly affecting the stand. If lucerne is sown in autumn, urea



Red root and red shank controlled in swedes by a pre-emergence application of T.C.A. at 20lb. to the acre applied under suitable moisture conditions.

compounds, namely C.M.U. and possibly D.C.M.U., can be used after the last autumn cut, or preferably applied in the dormant season so that the lucerne is not damaged by the slight contact action of the urea compounds. If cultivation is to be carried out, the urea compounds should be applied immediately after the cultivation and the area not disturbed further. Until further work is done, urea compounds should not be used in light, sandy soils under high rainfall conditions.

Clovers

White clover, red clover, and subterranean clover offer different tolerances to weedkillers; their resistance increases with age and changes occur in tolerance among the species with maturity. All species tolerate rates up to 6lb. of I.P.C. and C.I.P.C. applied as pre-emergence treatments, but T.C.A. is severe in its effect at rates above 5lb. Established clovers tolerate high rates of I.P.C. and C.I.P.C. without reduction in growth; rates up to 20lb. of T.C.A. do not markedly affect them. Maleic hydrazide at rates up to 4lb. does not reduce their growth at any stage of application past the 2 to 3 true leaf stage.

For young white clover salts of D.N.B.P. have proved more selective than hormone preparations based on 4-C, M.C.P., 2,4-D, 2,4,5-T, 2,4-DP, and 2,4,5-TP. For subterranean clover both water-soluble preparations of M.C.P. and 2,4-D have proved more selective than salts of D.N.B.P. For red clover only water-soluble M.C.P. preparations have proved more selective than salts of D.N.B.P. At early stages of growth preparations based on impure M.C.P. are more toxic to white clover than corresponding 2,4-D preparations, but with increasing age this is less apparent. Preparations of M.C.P. based only on the 2,4 isomer appear to be about equal with corresponding 2,4-D preparations. At the early stage 2,4-D is more toxic to red and subterranean clovers than M.C.P. preparations. Preparations of 4-C appear to slow up the growth of red and white clover, but are very damaging to subterranean clover. Esters of 2,4,5-T and 2,4,5-TP are very toxic to clovers at all stages of growth, subterranean clover being more resistant than white or red clover.

None of the available hormone preparations should be used on clovers prior to the sub-mature stage. After the sub-mature stage subterranean clover and white clover tolerate up to 1lb. of salts and amines of M.C.P. or 2,4-D with little or no damage. Esters are more severe, particularly the polyethylene glycol ester of 2,4-D. Only M.C.P. water-soluble preparations should be used on red clover at all stages of growth; 2,4-D is too toxic, even on mature plants. Esters of 2,4,5-T are toxic to clovers at all stages of growth and applications of rates as low as 1lb. could reduce clover in a sward for a period of several months. In pasture, the amount of clover damage is often reduced by prior hard grazing. Further work is required with M.C.P.B. and 2,4-DB.

Grass Seed Crops

Most grass species, once they have tillered, are resistant to hormone preparations until early flower-head formation. Once the seed has set they are again resistant to hormone preparations. The usual method is to hard graze the area, spray with the appropriate chemical, usually M.C.P. or 2,4-D, and close the area for a seed crop. The preparation employed should be governed by the weeds present and whether or not it is desired to suppress the clover present. If slight suppression of the clover is desired, then an ester of 2,4-D should be used at 1lb. to 2lb. If severe suppression is required, then an ester of 2,4,5-T should be used at 1lb. to 2lb. The use of crop desiccants for pre-harvest weed control and for drying of the seed crop prior to harvesting has also to be considered in areas where normal harvesting methods are uncertain.

Young Pastures

The use of weedkillers for weed control in young pastures is governed by the clover content rather than by the grasses present. If the white clover is the dominant legume, then D.N.B.P. preparations can be used at rates up to 2lb. under the correct conditions. An application of D.N.B.P. will control most germinating annuals and perennials from 0 to 4in. high. The advantage of this treatment over grazing is still to be fully assessed, but

a direct result of such an application is to allow better clover establishment. The use of hormone preparations cannot be recommended until the clover is at the sub-mature stage, that is, if pastures are autumn sown, then spraying should not be carried out until the following spring; and the reverse is true. The most selective hormone preparations should then be used, namely the salts and amines of M.C.P. and 2,4-D. These preparations will satisfactorily control most pasture weed species except docks. If docks are prevalent, then the amine salt of 2,4-D should be employed. If red clover is present in the sward, then preparations of 2,4-D should not be employed. Esters of 2,4-D should not be used unless weeds are present that can only be controlled by these preparations such as rush species other than the soft rush (*Juncus effusus*), lupin, and young goat's rue. Further

work is required with M.C.P.B. and 2,4-DB.

Old Pastures

Old pastures is used to describe pastures 1 year or more old and where the clovers present are established. Hormone weedkillers are of value for pasture weed control in three ways. First, for the elimination of weeds in the establishment stage of the young pasture where the competitive effect of the grasses and clovers is not enough to keep out weeds not normally found in a good pasture; secondly, for the control of weeds that appear under high fertility conditions, largely in dairy pastures, such as dock, buttercup, and thistles. In the third case, run-out pastures that are dominated by flat weeds can be oversown and topdressed and weedkillers used to destroy the weed content.



Strong invasion of white clover in an onion crop treated with C.I.P.C. The crop was free of weeds other than clover.

The use of hormone weedkillers is not recommended for the control of weeds that normally grow under low fertility conditions or occupy bare ground in poor pastures. Good examples of such weeds are the flat weeds, chamomile, stinking mayweed, and ox-eye daisy. The control of these weeds should be by pasture improvement methods. Trials have shown that if this type of weed is sprayed, the actual pasture production falls for a period, because most of the weeds are edible to stock. The spraying of these weeds should be followed up by pasture improvement methods.

Onions

Recent work on onions indicates that C.I.P.C. at rates of up to 6lb. to 8lb. applied immediately the seed is sown will give satisfactory control of germinating seeds with few exceptions, such as clovers. C.M.U. is very satisfactory at rates of 1lb. to 4lb. applied at pre-emergence under moist soil conditions. This treatment eliminates most weeds except flat weeds and some grasses such as *paspalum*. Alanap-1, at rates up to 4lb. applied as a pre-emergence treatment, gave inferior weed control to C.I.P.C. or C.M.U. Sulphuric acid used as a 10 per cent. solution at the rate of 65 to 100 gallons per acre has given inferior weed control to C.I.P.C. and C.M.U. where these treatments were applied under good conditions. Sulphuric acid is not toxic to grasses, clovers, and weeds with a waxy leaf such as purslane. Sulphuric acid is normally applied as a pre-emergence treatment and after the onions have passed the loop stage. If grass weeds are dominant, then I.P.C. at rates up to 6lb. or T.C.A. at rates up to 10lb. can be employed as a pre-emergence treatment.

Though not demonstrated in New Zealand, C.M.U. at rates up to 5lb. has given excellent weed control in onions set out for seed purposes.

Carrots

C.I.P.C. at rates of up to 8lb. or C.M.U. at rates up to 4lb. applied as a pre-emergence treatment immediately the carrot crop is sown have given good weed control particularly under moist conditions. Alanap-1, at rates up to

4lb., has given inferior weed control as a pre-emergence treatment. T.C.A. may also be used as a pre-emergence dressing at rates up to 20lb. A proprietary line of light aromatic oils, "Shell Weedkiller W", applied at rates up to 50 gallons when the carrots have 1 to 4 true leaves, has given good weed control. This material should preferably receive prior testing.

Asparagus

Many weedkillers may be used for asparagus weed control, but the best results have been obtained with C.M.U. The area should be freed of weeds that establish from regrowths before the asparagus is set out; then rates up to 5lb. of C.M.U. will keep the area free of most weeds establishing as germinating seedlings. The C.M.U. should be applied as soon as the asparagus is set out. This treatment should possibly be confined to heavy soil types. In established stands C.M.U. should be applied immediately after the last cultivation in spring before the spears emerge. C.I.P.C. applied after cultivation at rates up to 8lb. has given good weed control for 1 to 3 months. I.P.C. at the same rates has been inferior. Oktone at 4lb. and diesel fuel oil and parent phenols, at rates up to 4lb. fortified with diesel fuel oil, have also been satisfactory as pre-emergence applications, but the residual effect of these materials is soon lost.

Water-soluble M.C.P. preparations are satisfactory for the elimination of broad-leaved weeds if applied early in the season, preferably immediately after a cutting or when the asparagus is in the fern stage. The first application should not be greater than 0.75lb. Higher rates may be used in the fern stage.

Leeks

Very little work has been done on leeks in New Zealand. Sulphuric acid, C.I.P.C., and I.P.C. at up to 4lb. appear promising as a pre-emergence application. Further work is required.

Celery

No work has been done on celery in New Zealand. The possibility of using



Invasion of white clover in an otherwise clean carrot crop treated with C.I.P.C. White clover is resistant to C.I.P.C.

"Shell Weedkiller W" at 50 gallons per acre should be investigated for weed control in seed-beds.

Parsnips

Very little work has been carried out on parsnips in New Zealand. "Shell Weedkiller W" should be employed at rates up to 50 gallons after the development of the first true leaf. Parsnips are more susceptible than carrots and a test strip should be sprayed prior to spraying the whole crop.

Lettuce

Very little work has been done on lettuce and no recommendations can be made.

Beans

No trial work has been done on beans in New Zealand, but commercial work indicates that D.N.B.P. preparations (preferably the amine salts)

are satisfactory once the beans are 4in. to 6in. high. A more suitable method is the application of amine salts of D.N.B.P. at rates of 2 to 4lb. as a pre-emergence application. C.I.P.C. at rates up to 8lb. is satisfactory under moist soil conditions.

Tomatoes

No work has been done on tomatoes and no recommendations can be made.

Linseed and Linen Flax

T.C.A. at rates up to 20lb. can be used as a pre-emergence treatment for the control of grass weeds and several species of broad-leaved weeds. Water-soluble preparations are suitable as a post-emergence treatment when the linseed is about 2in. to 4in. high. Rates should not exceed 1lb. and preferably only sufficient material should be used to control the weeds present. Susceptible weeds will be killed by

these rates, but weeds such as red shank, cornbind, etc., will only be checked temporarily.

Beets (Fodder)

Only a little work has been done on fodder beets in New Zealand. T.C.A. may be employed at pre-emergence at rates up to 10lb., C.I.P.C. at rates up to 2lb. in cool soil conditions, applied at pre-emergence. There is some evidence that Dalapon may also be satisfactory at rates up to 10lb.

Cucurbits

No work has been done on cucurbits in New Zealand, but the manufacturers of Alanap-1 recommend this treatment at rates up to 6lb., as a pre-emergence treatment for cucumbers, watermelon, and pumpkin.

Strawberries

Sufficient work has been done to show that strawberries may be weeded by the use of salts of M.C.P. applied at rates up to 1lb. after the last harvest and until spring growth commences. I.P.C. and C.I.P.C. may also be used at rates up to 6lb. Salts of phenols may also be used during this period. Highly selective preparations such as S.E.S. at rates up to 6lb. may be used after the plants are set out. Applications would need to be applied as often as required (2- to 4-week intervals). This treatment does inhibit the formation of runners to a slight degree.

Grapes

Grapes may be weeded by contact type of herbicides such as parent phenols in diesel fuel oil used at rates of 1lb. to 2lb. phenol plus 10 to 15 gallons of diesel fuel oil plus sufficient water so that no spray drift is obtained. The spray should be kept away from the foliage and from young vines not protected by loose bark. Hormone preparations should not be used in or near grape vines.

Currants

Parent phenols at 1 to 2lb. emulsified with diesel fuel oil and water are suitable for keeping currants weeded,

particularly in the dormant season. The spray should be directed so that it will not touch the currant plants.

Raspberries and Blackberries

Parent phenols at 1lb. to 2lb. emulsified with diesel fuel oil and water are suitable, particularly in the dormant season, as a directed spray. Water-soluble M.C.P. preparations are also suitable at rates up to 1lb., except at the flowering period. Care should be taken not to spray the tips of young canes or the foliage.

Lawns and Playing Greens

Most broad-leaved weeds (such as the flat weeds) may be eliminated in lawns and playing greens by using the water-soluble preparations of M.C.P. at rates up to 1lb. Equivalent preparations of 2,4-D are not quite as suitable, as they tend to check browntop. If ester preparations are employed, only low volatile esters should be used at rates up to 1lb. The above treatments will kill suckling clover and germinating white clover, but will not materially affect established clover. Low volatile esters of 2,4,5-T should be used at rates up to 3lb. for clover elimination. A suitable weedkiller for the destruction of both broad-leaved weeds and clovers is a mixture of low volatile esters of 2,4-D and 2,4,5-T made up of 0.5lb. of 2,4-D and 2.5lb. of 2,4,5-T. An equivalent ester of M.C.P. would be more suitable than 2,4-D, but no such esters are commercially available. No proprietary mixture of 2,4-D and 2,4,5-T is available in the correct proportion on the market, but users could purchase the equivalent low volatile esters of 2,4-D and 2,4,5-T and mix these in the right proportions. The same proprietary lines should be employed.

Users should note carefully the precautions itemised under the section on hormone weedkillers.

If 2,4,5-T is employed to eliminate the clovers present, then application of 2,4,5-T should be followed up by the addition of a nitrogenous fertiliser, if thrift of the lawn is to be maintained.

The weedkillers should preferably be applied in spring and autumn.

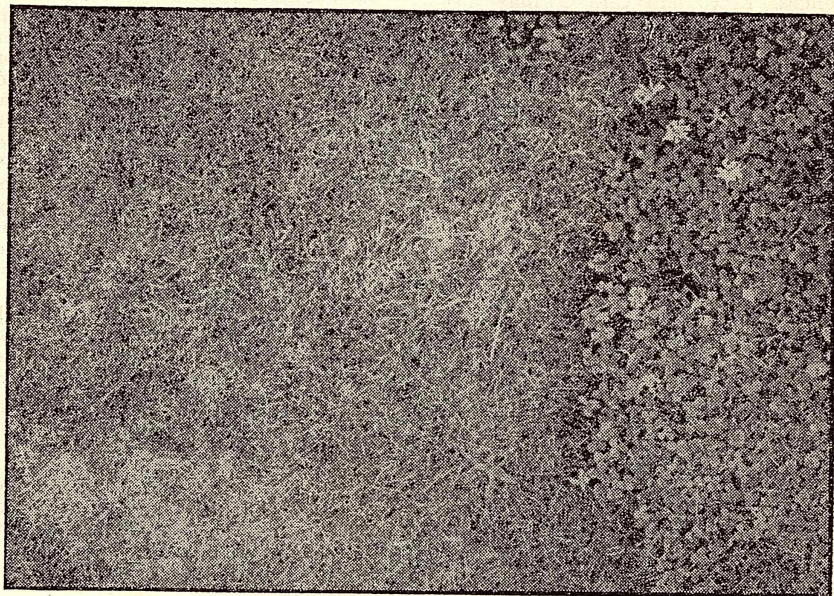
Poor weed control results if the application is made under very dry conditions when growth is slow. Sufficient work has not been done to make recommendations for the elimination of annual weed grasses in lawns. Isolated plants of established perennial grasses may be eliminated by a spot treatment of T.C.A. or Dalapon at $\frac{1}{4}$ oz. to $\frac{1}{2}$ oz. per plant, applied dry.

Waste Areas, Footpaths, and Drives

The most satisfactory chemicals for the complete control of weeds in waste areas, footpaths, and drives are soil sterilants such as C.M.U., "Polyborchlorate", Borascu, and "Atlacide". High rates of these materials are required to kill off established vegetation. C.M.U. needs to be applied at rates of 40 to 80lb., "Polyborchlorate" and "Atlacide" at rates over 1000lb., and Borascu at rates up to 2000lb. Thus, to kill off established vegetation with these materials is costly. If the area is weed-free to

begin with, then lower rates of these chemicals are required to keep vegetation from establishing. C.M.U. at rates up to 80lb. has kept areas weed-free for a period exceeding 2 years where the soil type is fairly heavy. The other chemicals, particularly "Atlacide" and "Polyborchlorate", even at rates up to 4000lb. have been much less satisfactory under the same conditions. The application of all these materials should not be made to areas where movement of the chemical by surface water on to valuable areas can take place.

Before drives or paths are laid it is advisable to kill off all weeds present. This should be done particularly in the case of areas put down to asphalt or other tar-like products. An area at least 2ft. wide should be kept free of weeds around the perimeter of an asphalt area. This is necessary to stop plants sending root suckers under the asphalt. The above chemicals can also be used to kill weeds growing in the cracks in the paths.



White clover elimination in a bowling green with 2,4,5-T applied at 3lb. acid equivalent per acre.

SECTION 4 — THE MOST IMPORTANT WEEDS IN NEW ZEALAND AND PROBLEMS IN THEIR CONTROL

In a recent survey where instructors were requested to present papers on weed problems in their districts the most common field weed problems—in descending order of importance—were weeds in brassicas, Californian thistle, docks, gorse, weeds in lucerne, rushes, hard fern, water weeds and weeds in drains, twitches (couch grasses), and tall fescue. Of localised importance are nassella tussock, sweet brier, giant buttercup, blackberry, barley grass, weeds in peas, and weeds in new pastures.

Brassicas

Progress has been made with weed control in brassicas, but control of weeds is not as satisfactory and easy as killing, say, wild turnip in cereal crops.

In the past 4 years it has been shown that T.C.A. applied immediately the crop is sown under suitable moisture conditions will give good control of most germinating seedlings at rates up to 20lb. Spurrey is checked or killed by these rates. C.I.P.C. is very toxic to spurrey, but also suppresses the germination of brassicas at rates above 1lb. to 2lb., and especially under warm, moist soil conditions. Oktone plus aromatic oil has given good weed control over a wider range of conditions than T.C.A. or C.I.P.C., but under cool soil conditions it is necessary to use a light aromatic oil such as kerosene or even benzene; otherwise the residual effect of the oil reduces the germination of the brassicas. Broad-leaved weeds establishing from root regrowths, such as Californian thistle, cannot be controlled in brassicas. Grass weeds arising from root regrowths such as couch are controlled by T.C.A. at rates up to 20lb.

Californian Thistle

The control of Californian thistle is fairly satisfactory. Its importance is due to its widespread prevalence. It is satisfactorily controlled in any association where water-soluble M.C.P. preparations may be employed: wheat, barley, oats, maize, potatoes, asparagus, raspberries, pastures 6 or more months old, and waste areas. Established areas in old pastures require several applications for control. These applications

should be made after the plant has reached the maximum leaf stage so that the sprayings are required to be conducted over several years. Control is more readily obtained in conjunction with cultivation. The cultivation serves to break up the dormant underground root systems so that each plant tends to rise from a short length of rootstock. Plants growing from a short length of rootstock are usually killed by one application, provided the spraying is done after the maximum leaf stage. Californian thistle is usually at this stage 4 to 6 months after cultivation and can thus be controlled in newly sown pastures. The control of Californian thistle is not feasible in crops where selective preparations such as C.I.P.C., Alanap-1, etc., require to be employed. In these areas Californian thistle should be eradicated before the crops are sown.

Docks

Docks are probably increasing with the build up of fertility in dairy pastures and are a problem in many other areas. Established docks are difficult to control. In established pasture, control may be obtained by amine salts of 2,4-D, and the polyethylene glycol ester of 2,4-D at rates of 2lb. applied in the late flowering stage. Clover damage is usually severe, particularly with the water-soluble ester, and often more than the one application is required. This should be made after the regrowth docks have reached the maximum leaf stage. Far better results are obtained by cultivating areas of established docks. The cultivation should include chopping of the roots into short pieces, then sowing a brassica crop, treating this at pre-emergence with up to 20lb. of T.C.A., and then sowing the area to a pasture. T.C.A. under the right moisture conditions controls germinating dock seeds. Seedling docks and young regrowth docks can be treated in the new pasture with up to 1lb. of amine 2,4-D the following spring or autumn after the pasture is sown. Further infestations of docks should be kept under control by an annual application of amine 2,4-D. There is a possibility that M.H. compounds may be used in the early establishment stages in a young pasture.

Docks are very prevalent in lucerne and clover seed crops. Seedling and regrowth docks arising from short rootstocks are successfully controlled in these crops with M.H. compounds applied at rates of 1lb. to 2lb., preferably after the last autumn cut in the case of lucerne, after harvesting in the case of seed crops, or early in the spring before the hot weather hardens the foliage of the dock leaves. M.H. gives poor control of established woody docks, so that the time of application is important.

Gorse

The control of gorse up to a sub-mature stage of growth is fairly satisfactory, particularly in waste areas. Its importance is due to its widespread prevalence; there is possibly in the vicinity of 100,000 acres of gorse in New Zealand on country that would be productive if it were not for the presence of gorse. The two major problems to be overcome, particularly for gorse on hill country too steep for tracklaying tractor operations, is one of application of the material, and secondly the control of seedling and regrowth gorse in the establishment stages of the young pasture or areas that have been oversown. Seedling and regrowth gorse is readily killed by 2,4,5-T, but this material is very toxic, particularly to red and white clover. In practice, the clover is virtually eliminated by the 2,4,5-T, but comes in a year later.

On country too steep for tracklaying tractor operation the best control of gorse is probably obtained by applying a light rate of 2,4,5-T (1lb.) by air in late spring. The area should then be burnt, oversown, and top-dressed in autumn where oversowing is satisfactory. Regrowths should be treated 1 to 2 years later at rates up to 2lb. The light spraying in late spring helps to obtain a clean burn of the stumps, particularly if a slow back-burn is obtained. In areas where oversowing is of little value the gorse should be sprayed and fertiliser applied. There is often sufficient grass and clover seed in the ground to cover the area.

Weeds in Lucerne

In any perennial crop where the full use of cultivation is restricted weeds are a problem. Weeds come into a

lucerne crop mainly at two periods; in the establishing stages of the lucerne and again in the dormant period. Weedkillers are suitable for weed control at both these periods. The first essential before sowing lucerne is to free the area of weeds that arise largely from root regrowths, such as Californian thistle and twitches (couch grasses). Germinating seedlings can then be controlled by pre-emergence application of I.P.C. or C.I.P.C. at rates up to 4lb. or by post-emergence application of salts of phenols at rates of 1lb. to 2lb. after the 2 to 3 true leaf stage of the lucerne. In the dormant season T.C.A. can be used at rates up to 30lb. to control establishing grasses. This rate may reduce the growth of lucerne up to the first cut. Once the lucerne is fully established applications of urea compounds up to 5lb. applied in the dormant season to clear land show promise of keeping the area weed free. Very often docks are a problem in lucerne. The application of C.I.P.C. at 4lb. at pre-emergence will give good control of germinating docks. Once the lucerne is established seedling and fresh regrowth docks may be eliminated by the application of M.H. compounds at 1lb. to 2lb. M.H. equivalent. The control of established docks in old lucerne stands is difficult. Some control of "old-man" docks can be obtained by M.H. compounds if they are applied to the fresh regrowth after mowing.

Rushes (*Juncus* spp.)

The importance of rushes is due to their widespread prevalence. The main tall-growing species may all be successfully controlled with hormone preparations. *Juncus vaginatus* is probably susceptible, particularly if growing under good conditions. No work has been done on *Juncus pauciflorus* because it is not very common. Rushes are often a problem in the early establishment stages of pastures in damp areas and particularly in areas where the fertility has not been raised sufficiently to support a first-class pasture such as on peat and wet sand country. Most species of seedling rushes can be killed by an application of amines and esters of 2,4-D at rates up to 1lb. Application of weedkillers can be made the spring or autumn after sowing. Thus weedkillers may be used to

keep pastures free of rushes during the establishment stages. Weedkillers are also of value for the control of rushes in areas where drainage is difficult out which dry out sufficiently in summer to be grazed.

Hard Fern

Hard fern is a problem because it grows on hill country and to date there is no positive and easy method of control. If preparations of 4-C prove satisfactory, there is still the difficulty of application. Burning usually kills all but the outside ring. The roots of the outside ring are usually too deep to be killed by firing. The most successful method would be to burn, oversow, and fertilise in autumn and then treat the regrowths the following spring. The amount of spraying to be done per acre would be small. If low volume nozzles and relatively high pressures are employed, a few gallons of water per acre should be satisfactory. One or more applications are probably necessary for control.

Drain and Water Weeds

The control of broad-leaved emergent weeds such as watercress, monkey musk, etc., is satisfactory, but the control of other types of weeds is difficult, and this is the main reason why this problem is ranked so high. There are no suitable chemicals available for the control of floating or submerged weeds. Preparations available are toxic to fish life, hence their use is limited. Floating, emergent grass weeds such as reed sweet grass are not successfully controlled except where they root on dry land. The possibility of Dalapon for this type of weed is still to be determined.

Twitches

Twitch-like grasses in one form or another are fairly prevalent throughout New Zealand. The main species include dryland browntop, "old-man" twitch, *Paspalum distichum*, *Paspalum dilatatum*, creeping bent, onion-rooted twitch, kikuyu, Kentucky blue grass, Indian doub, *Pennisetum macrourum*, and creeping fog. In areas where a dry summer fallow is possible good control of twitch-like grasses can be obtained. This method has the disadvantage that the ground is not utilised for a period and that possibly there is no beneficial effect from

the fallowing if it is continued longer than is necessary for seed-bed preparation. The effectiveness of grass-killing chemicals has made it possible to control twitch-like grasses without the necessity of fallowing, particularly in the wetter areas of New Zealand. Rates of 20lb. to 25lb. of T.C.A. are sufficient to control most twitch-like grasses in conjunction with cultivation. The cultivation technique employed should aim at promoting the growth of weed grasses; hence the activation of dormant rhizomes by discing or rotary hoeing if necessary. A suitable method of using T.C.A. is to plough the area, do sufficient cultivation to prepare a seed-bed, and promote the growth of the twitch-like grass, sow a T.C.A.-resistant crop and apply T.C.A. immediately the crop is sown. This application is sufficient to kill many germinating seedlings of broad-leaved plants such as fat-hen, willow weed and germinating seedling grasses. The one application of T.C.A. is not sufficient to eradicate the twitch grass in question, but cultivation necessary for the welfare of the crop such as potatoes, or the preparation of a seed-bed after the crop is lifted or fed off in the case of brassicas, is usually sufficient to give a high percentage of control. If this method is followed, particularly in arable areas where the weed content has been built up in the past, there is promise that the weed seed content in the soil may be reduced. Further, most weeds that show resistance to hormone weedkillers are susceptible to T.C.A. at the germinating stage.

Tall Fescue

Tall fescue has been listed as a major problem because there are no means of controlling it selectively in newly drained swamp areas or river flats. Germinating seedlings can be killed readily enough with T.C.A. in a brassica crop, but effective control is not possible with this chemical in areas where cultivation is not possible and the application has to be made on mature plants. Dalapon may prove successful for its control, but the treatments would have to be made as spot treatments, as Dalapon is non-selective to grasses and young clovers.

Nassella Tussock

There are at least 50,000 acres of medium to dense nassella tussock in

localities from Blenheim to as far south as Ashburton. Trials carried out to date include burning, oversowing and fertilising, planting of various trees and shrubs, grazing trials, spraying nassella with common salt and other materials to make it more edible, and trials with weedkilling chemicals. The most successful results have been with T.C.A. Insufficient work has been done with this material to indicate the optimum time it should be applied. For one area the optimum months were January or February. Poorer results were obtained in December and March; and for the other months little or no control was obtained. The efficiency of Dalapon has still to be determined. At the moment up to 2000 acres that are regarded as nucleus areas for further spread are being sprayed annually. In some areas complete kills of the nassella are obtained; in other areas seeding is restricted. The major problem to be solved, once the nassella is controlled, is the replacement of nassella by suitable vegetation.

Sweet Brier

Sweet brier has come into prominence mainly on the steep foothills of the Southern Alps and Central Otago with the reduction in number of rabbits. In the past rabbits largely kept sweet brier in control. Until there is a selective chemical available that can be applied from the air in a minimum amount of water and that will control sweet brier with one application, there is little hope of controlling this weed. Esters of 2,4,5-T applied from flower to hip formation do secure control, but several applications are required in the absence of heavy stocking to kill plants. Complete foliage cover is very essential, hence this method is not practical on steep country. Basal applications of 2,4,5-T and diesel fuel oil are also satisfactory for isolated plants. Again, repeat applications are usually required for control, hence this method is only practical for the control of nucleus areas.

Giant Buttercup

Giant buttercup has assumed importance in the past few years possibly because of the following reasons:—

Buttercups in general are increasing

with the methods adopted to secure higher production on dairy farms, and in replacing weeds killed by 2,4-D applications. Giant buttercup is resistant to 2,4-D applications, but is readily controlled by water-soluble M.C.P. preparations at rates up to 2lb.

Blackberry

Blackberry is prevalent in New Zealand. Control or eradication with 2,4,5-T is satisfactory. In waste areas one to several applications of 2,4,5-T are required to kill blackberry, but in conjunction with oversowing and stocking usually one application is sufficient for control. If 2,4,5-T is applied at a minimum lethal dose per acre in the late summer-early autumn months, there are so few regrowths the following spring that stocking is sufficient to give complete eradication. The commonest cause of failure in blackberry spraying is the application of the material to the blackberry before the maximum leaf stage and excessive rates of application. In both cases a contact type of kill results and strong regrowths occur even in the same season that the spray is applied.

Barley Grass

With the build-up of fertility, particularly in areas that open up due to summer dry weather, barley grass is increasing rapidly. It may be controlled by rates of 10lb. of T.C.A. applied when the barley grass is germinating. Rates of I.P.C. up to 4lb. or rates over 4lb. of C.I.P.C. are also satisfactory. However, all these treatments do affect associated grasses of value to some extent. T.C.A. may reduce the growth of the grass for a period of several weeks; I.P.C. and C.I.P.C. for one to several months. The over-all production per acre may not fall, as clover comes in at the expense of the grasses. These treatments are sufficiently good to be used for the control of nucleus areas, but over-all applications could not be recommended.

Weeds in Peas

The growing of peas for canning and deep freezing is increasing in New Zealand. The control of weeds is largely satisfactory by phenols, but the poisonous properties of these materials

do not allow them to be used freely by the general public. Special equipment should be used for their application. If suitable preparations based on hormones become available, then weed control in peas will be more satisfactory.

Weeds in New Pastures

The main problems with weeds in new pastures are associated with the fact that the value of controlling weeds in the establishment stages of the pasture is not full realised. Most annual weeds are controlled by grazing, but the competitive effect of the weeds plus that of the quicker-establishing grasses such as ryegrass is often sufficient to suppress the slower-establishing clover. If this occurs, then the area is grass dominant for the first year, but then the grasses fail because of lack of nitrogen and the

area becomes clover dominant. The application of weedkiller, particularly in areas too wet to graze sufficiently to control the weeds, will result in a better establishment of clover. To date the only suitable preparations to use are the phenols, but there is promise that some of the newer hormone derivatives will be of value. There is a possibility also that where docks are prevalent M.H. compounds may be used for the control of the docks and at the same time reduce the growth of the grasses present to allow a better establishment of the clovers.

Acknowledgments

The common and botanical names used for the broad-leaved plants have been verified by Mr. A. H. Healy, Assistant Director, Botany Division, Department of Scientific and Industrial Research.

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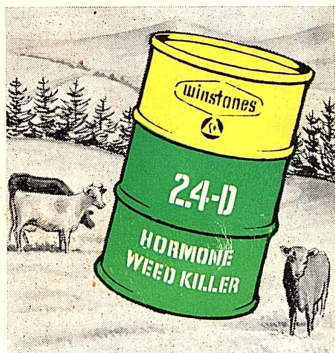
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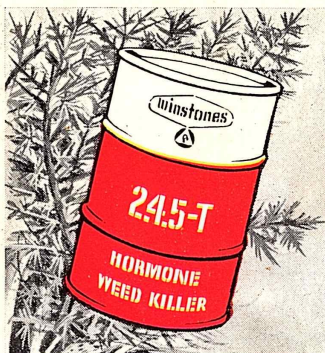
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